ENVIRONMENTAL RADIATION MONITORING PROGRAM PLAN FOR LICENSE SUB-1435 JEFFERSON PROVING GROUND

FINAL

Submitted to:
Nuclear Regulatory Commission
Office of Nuclear Material Safety and Safeguards
Washington, D.C.

Prepared by:
U.S. Department of Army
Soldier and Biological Chemical Command
Aberdeen Proving Ground

September 2003

TABLE OF CONTENTS

1. INTRODUCTION 1-1
- 1.1 OBJECTIVE AND SCOPE 1-1
- 1.2 STATUS OF NRC LICENSE SUB-1435 1-1

2. PROJECT BACKGROUND 2-1
- 2.1 SITE DESCRIPTION 2-1
- 2.2 HISTORY OF LICENSED ACTIVITIES 2-1
- 2.3 NATURE AND EXTENT OF RADIOLOGICAL CONTAMINATION 2-2
  - 2.3.1 Scoping and Characterization Surveys 2-2
  - 2.3.2 ERM Program 2-4
  - 2.3.3 Regional Range Study 2-4

3. ERM PROGRAM STRATEGY AND PLAN 3-1
- 3.1 ERM GOALS AND RATIONALE 3-1
- 3.2 DATA QUALITY OBJECTIVES 3-1
- 3.3 RADIATION MONITORING STRATEGY AND PLANS 3-2
  - 3.3.1 Groundwater 3-4
  - 3.3.2 Surface Water 3-5
  - 3.3.3 Sediment 3-7
  - 3.3.4 Soil 3-9
  - 3.3.5 Air 3-10
  - 3.3.6 Biota 3-11

4. PROJECT ORGANIZATION AND MANAGEMENT 4-1
- 4.1 RESPONSIBLE ORGANIZATIONS 4-1
  - 4.1.1 Nuclear Regulatory Commission 4-1
  - 4.1.2 U.S. Army Soldier and Biological Chemical Command 4-1
  - 4.1.3 Contractors 4-1
- 4.2 LINES OF AUTHORITY 4-2
- 4.3 KEY MANAGEMENT POSITIONS 4-2
  - 4.3.1 Soldier and Biological Chemical Command 4-2
  - 4.3.2 Contractor (SAIC) 4-3

5. FIELD PROGRAM 5-1
- 5.1 SAMPLING PROTOCOL 5-1
  - 5.1.1 Pre-Mobilization Activities 5-1
  - 5.1.2 Groundwater Sample Collection 5-1
  - 5.1.3 Surface Water Sample Collection 5-2
  - 5.1.4 Sediment Sample Collection[1] 5-4
- 5.2 SAMPLE HANDLING AND MANAGEMENT 5-6
  - 5.2.1 Sample Containers 5-8
  - 5.2.2 Sample Volumes, Types, and Preservative Requirements 5-8
  - 5.2.3 Quality Control Samples 5-8

5.2.4 Sample Identification 5-9
5.2.5 Sample Custody 5-9
5.3 FIELD MEASUREMENTS 5-10
5.3.1 Field Parameters 5-10
5.3.2 Equipment Calibration and Quality Control 5-11
5.3.3 Equipment Maintenance and Decontamination 5-12
5.4 WASTE MANAGEMENT 5-12
5.5 RECORDKEEPING 5-13

6. SITE ACCESS CONTROLS 6-1

7. 5-YEAR REVIEWS 7-1

8. REFERENCES 8-1

Appendix A. Assessment of Historical Data A-1
Appendix B. Quality Assurance Project B-1
Appendix C. Site Safety And Health Plan C-1

LIST OF FIGURES

2-1. Sampling Locations Under the ERM Program (U.S. Army 2000a) Jefferson Proving Ground, Indiana 2-5
4-1. Chain of Command for the JPG ERM Program Jefferson Proving Ground, Indiana 4-2
6-1. Potential Public Uses at the Big Oaks National Wildlife Refuge Jefferson Proving Ground, Indiana 6-2

LIST OF TABLES

3-1. ERM Program Plan: Monitoring Plans and Associated Action Levels Jefferson Proving Ground, Indiana 3-3
4-1. Key Organizations, Positions, and Contact Information for the Environmental Radiation Monitoring Program Jefferson Proving Ground, Indiana 4-3
5-1. Analytical Method and Total Number of Groundwater Analyses Jefferson Proving Ground, Indiana 5-1
5-2. Groundwater Sample Collection Worksheet for the ERM Program Jefferson Proving Ground, Indiana 5-3
5-3. Analytical Method and Total Number of Surface Water Analyses Jefferson Proving Ground, Indiana 5-4
5-4. Surface Water Sample Worksheet for the ERM Program Jefferson Proving Ground, Indiana 5-5
5-5. Analytical Method and Total Number of Sediment Analyses Jefferson Proving Ground, Indiana 5-5
5-6. Sediment Sample Worksheet for the ERM Program Jefferson Proving Ground, Indiana 5-6
5-7. Chain-of-Custody (COC) Record Jefferson Proving Ground, Indiana 5-7
5-8. Sample Volumes, Types, and Preservative Requirements for Groundwater, Surface Water, and Sediment Samples Jefferson Proving Ground, Indiana 5-8

This page intentionally left blank.

LIST OF ACRONYMS AND ABBREVIATIONS

ANG	Air National Guard
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
BRAC	Base Realignment and Closure
^{o}C	degrees Celsius
CFR	Code of Federal Regulations
CHPPM	Center for Health Promotion and Preventative Medicine
cm	centimeter
COC	chain of custody
DI	de-ionized
DMSO	Defense Modeling & Simulation Office
DOT	U.S. Department of Transportation
DQO	data quality objective
DU	depleted uranium
EPA	U.S. Environmental Protection Agency
ERM	Environmental Radiation Monitoring
ft	foot
FWS	U.S. Fish and Wildlife Service
ID	identification
IDEM	Indiana Department of Environmental Management
IDW	investigation derived waste
in.	inch
JPG	Jefferson Proving Ground
kg	kilogram
km	kilometer
km^2	square kilometer
L	liter
lb	pound
LCS	laboratory control sample
LOR	letter of receipt
m	meter
µCi/ml	microcuries per milliliter
MCL	maximum contaminant level
µg/L	micrograms per liter

µR/hr	microroentgen per hour
mg/m^3	milligrams per square meter
ml	milliliter
mrem	millirem
MS/MSD	matrix spike/matrix spike duplicate
MW	monitoring well
NA	not applicable
NRC	Nuclear Regulatory Commission
NWR	National Wildlife Refuge
pCi/g	picocuries per gram
pCi/L	picocuries per liter
PID	photoionization detector
QAAP	quality assurance administrative procedure
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
RAB	Restoration Advisory Board
RDX	Royal Demolition Explosive (Cyclotrimethylenetrinitramine)
RPO	Radiation Protection Officer
SAIC	Science Applications International Corporation
SBCCOM	Soldier and Biological Chemical Command
SEG	Scientific Ecology Group
SOPC	substance of potential concern
SSHP	Site Safety and Health Plan
U-238	Uranium 238
USAF	United States Air Force
UXO	unexploded ordnance

1. INTRODUCTION

This plan details the environmental radiation monitoring (ERM) Program Plan for the Depleted Uranium (DU) Impact Area at Jefferson Proving Ground (JPG), Madison, Indiana. The ERM program is being conducted in accordance with the terms and conditions of the U.S. Army Soldier and Biological Chemical Command's (SBCCOM) Nuclear Regulatory Commission (NRC) License SUB-1435 (NRC 1996). This ERM Program Plan supersedes, in its entirety, the Standard Operating Procedure dated March 2000 (U.S. Army 2000a).

Section 1 of this plan states the purpose and scope of this ERM Program Plan and provides a summary of the licensing status of the facility. Section 2 provides an overview of the site and its history related to NRC License SUB-1435.

The ERM program objectives, strategy, and associated action levels for the environmental media of concern are detailed in Section 3. The project organization and the roles and responsibilities of organizations associated with this program are defined in Section 4. The field program is presented in Section 5 and includes procedures associated with sample collection and management, field measurements, equipment preparation and decontamination, waste management, and recordkeeping. Site access controls are specified in Section 6. Procedures for reviewing the ERM Program Plan every 5 years are outlined in Section 7. References used in this report are noted in Section 8. The appendices (Appendices A, B, and C) address the historical data assessment, quality assurance project plan (QAPP), and site safety and health plan (SSHP), respectively.

1.1 OBJECTIVE AND SCOPE

The objective of this ERM Program Plan is to define the strategy and associated procedures for sampling environmental media within and surrounding the DU Impact Area at JPG and to provide the basis for determining if onsite and offsite receptors are or will be at risk from exposure to DU.

The scope of this plan is limited to the DU Impact Area at JPG and its immediate environs and to sampling media to determine the presence or absence of DU. DU concentrations will be compared to action levels to determine if followup action is necessary.

1.2 STATUS OF NRC LICENSE SUB-1435

The U.S. Army has proposed that NRC License SUB-1435 (NRC 1996) be amended to create a 5-year renewable, possession-only license for an indefinite period (U.S. Army 2003). If this amendment is negotiated successfully with the NRC, the Army formally will withdraw the revised Decommissioning Plan (U.S. Army 2002a) and Environmental Report (U.S. Army 2002b) for decommissioning JPG.

As a condition of acceptance of this license amendment proposal, the NRC will require the implementation of an ERM program that defines, among other matters, the following: (1) action levels and associated procedures in the event that action levels are exceeded for monitored media and (2) continued restricted access to the DU Impact Area (NRC 2003). If this license amendment is successfully negotiated, this ERM Program Plan and any associated amendments or updates will be implemented in accordance with the license amendment conditions.

This page intentionally left blank.

2. PROJECT BACKGROUND

This section provides an overview of the site (Section 2.1), followed by a summary of licensed activities (Section 2.2). A brief summary of the environmental sampling program conducted in support of the scoping and characterization surveys and ERM program is presented in Section 2.3. An analysis of historical sampling data was completed in support of defining the sampling program delineated in Section 3. Additional details about the sampling program are provided in source documentation (e.g., U.S. Army 1991 and 1995a; SEC Donahue 1992; Scientific Ecology Group [SEG] 1995a, 1995b, and 1996; and Ebinger and Hansen 1996a and b).

2.1 SITE DESCRIPTION

JPG was established in 1941 as a proving ground for the test firing of a wide variety of ordnance. The facility is approximately 55,264 acres (224 square kilometers [km^2]) and is located in Jefferson, Jennings, and Ripley Counties in southeastern Indiana. A firing line with 268 gun positions used for testing ordnance separates JPG into two areas: a 4,000-acre (16.1-km^2) southern portion and a 51,000-acre (206-km^2) northern portion (Science Applications International Corporation [SAIC] 1997).

The U.S. Army used JPG as a proving ground from 1941 to 1994. During this time, more than 24 million rounds of conventional explosive ammunition were fired. Approximately 1.5 million rounds did not detonate upon impact, remaining as unexploded ordnance (UXO) either on or beneath the ground surface. This remaining UXO and its hazard has been a major factor in decisions about managing the area north of the firing line (SAIC 1997).

2.2 HISTORY OF LICENSED ACTIVITIES

As part of its munitions testing program, the JPG test-fired DU projectiles. The DU test firings were conducted under a license issued by the NRC (License SUB-1435, Docket 040-08838). The test firing of DU projectiles occurred between 1983 and 1994.

The DU projectiles were fired from three fixed-gun positions on the firing line at soft (cloth) targets placed at intervals of 3,280 feet (ft) [1,000 meters (m)], starting at 3,280 ft (1,000 m) from the gun position and continuing to 13,123 ft (4,000 m). Because of the type of testing performed, the DU projectiles would impact in approximately the same location each time on their respective lines of fire. This firing protocol, with repeated impacts in the same area, resulted in the formation of a trench approximately 3.4 ft (1 m) deep by 16.4–26.3 ft (5–8 m) wide extending for approximately 3,937 ft (1,200 m) at the most frequently used gun position (SEG 1996). These tests were non-destructive (i.e., no aerosolization occurred), although the rounds may have fragmented upon impact.

The primary impact location was the trench. Secondary impact locations developed when the projectile skipped, either whole or in fragments. A similar pattern was repeated at each of the other two firing positions but to a lesser extent because a smaller quantity of DU was fired from each of these locations (SEG 1996).

Approximately 220,462 pounds (lbs) (100,000 kilograms [kg]) of DU projectiles were fired at soft targets in a 2,080-acre (8.4-km^2) DU Impact Area. Approximately 66,139 lbs

(30,000 kg) of DU projectiles and projectile fragments were recovered. Approximately 154,323 lbs (70,000 kg) of DU remain in the DU Impact Area (SEG 1995b and 1996).

The JPG was closed in September 1995 under the Defense Authorization Amendments and Base Realignment and Closure (BRAC) Act of 1988. At that time, the area south of the firing line where DU was stored was surveyed to determine the extent of DU contamination. Any contaminated areas were decontaminated, and the total area south of the firing line was released for unrestricted use in 1996. The NRC license for the area north of the firing line was amended for possession of DU only in May 1996.

Decommissioning Plans were submitted by the Army in December 1999 and June 2001. The NRC discontinued review of the 1999 Decommissioning Plan with the release of the 2001 Decommissioning Plan. The NRC rejected the 2001 Decommissioning Plan during an expanded acceptance review noting the need for additional information, including offsite transport modeling. In a revised Decommissioning Plan dated June 27, 2002 (U.S. Army 2002a), the Army addressed the deficiencies noted with respect to the 2001 Decommissioning Plan and proposed to decommission JPG under restricted-release conditions in compliance with Title 10, Code of Federal Regulations, Part 20.1403 (10 CFR 20.1403). After completing an expanded acceptance review, the NRC accepted the 2002 Decommissioning Plan for technical review.

Given the unique conditions at JPG and the difficulty in obtaining data to support the decommissioning process, the U.S. Army requested to delay decommissioning (i.e., withdraw its Decommissioning Plan [U.S. Army 2002a] and Environmental Report [U.S. Army 2002b]) indefinitely and to continue to retain the possession-only license currently in effect at the site (U.S. Army 2003). If approved by the NRC, the possession-only license will be issued for a 5-year renewable period and the status evaluated at license renewal to determine if it is appropriate to begin site decommissioning (NRC 2003). This ERM Program Plan, which supersedes in its entirety the current ERM program as documented in the Standard Operating Procedure dated March 2000 (U.S. Army 2000a), will be used to implement the ERM program under the possession-only license.

2.3 NATURE AND EXTENT OF RADIOLOGICAL CONTAMINATION

This section provides a top-level summary of historical and ongoing assessments of the DU Impact Area. The two key assessments include the scoping and characterization surveys (Section 2.3.1) and the ERM program (Section 2.3.2). A third assessment, the regional range study, addressed the impact of range operations on environmental media and biota (Section 2.3.3).

2.3.1 Scoping and Characterization Surveys

The nature and extent of radiological contamination in the DU Impact Area were assessed in scoping and characterization surveys (SEC Donahue 1992 and SEG 1995a, 1995b, and 1996). In addition to determination of exposure rate measurements, the groundwater, surface water, sediment, soil, and biota samples were collected and analyzed in support of these assessments.

In the 1994 and 1995 characterization studies, remediation and a final survey were completed for facilities and grounds located south of the firing line. The characterization

activities identified several facilities in which DU contamination from handling DU projectiles was greater than allowable NRC limits. After remediation, the final survey confirmed that these facilities were decontaminated to the extent that any measured radioactivity was well below applicable NRC limits for uranium, beta emitters, and gamma radiation. In addition, the survey confirmed that the three gun-firing positions were not contaminated with DU in excess of NRC regulatory limits applicable at that time.

In 1994 and 1995, SEG conducted a radiological scoping survey (SEG 1995b) and a radiological characterization survey (SEG 1996) of the DU Impact Area of the JPG that was affected by firing approximately 220,462 lbs (100,000 kg) of DU projectiles between 1983 and 1994. The primary result of the scoping survey of the DU Impact Area was identification of the affected area within the larger firing range. The affected area of approximately 125 acres (0.5 km^2) was determined by measurements of DU concentrations in the soil in excess of a 35 picocuries per gram (pCi/g) action level for uranium (based on thorium measurements using gamma spectroscopy) (U.S. Army 2002a).

The characterization survey was performed to obtain more detailed information regarding the location and extent of DU contamination in the affected area of 125 acres (0.5 km^2), which was previously identified by the scoping survey. A total of 235 environmental samples, including soil, surface water, groundwater, sediment, vegetation, and animals, were obtained and measured for DU concentration. Soil samples included depths of up to 17.7 inches (in.) (45 centimeters [cm]), as well as samples from the affected DU trajectory area, including soil directly under extant DU penetrators. Uranium isotope concentrations were measured, and the Uranium 238 and 234 (U-238/U-234) activity ratio was calculated for each measurement. Together, the magnitude of uranium concentration and the U-238/U-234 ratio constitute a determination of the extent and nature of any uranium contamination.

Using the correlation of 14.4 microroentgen per hour (μR/hr) as the indicator of greater than 35 pCi/g action level for soil, the characterization survey identified specific regions within the affected area that are in excess of this concentration. Only two affected area surface water measurements, for stagnant water pools, exceeded guidelines for uranium in water. Affected area soil, sediment, and groundwater uranium measurements were well within the guidelines. Concentrations of uranium were high for soil in and around actual DU penetrator locations in the affected area. The characterization survey also identified that the top 4.3 in. (11 cm) of soil in the affected area would exceed the 35 pCi/g action level for uranium based on a 95th percentile analysis of DU in soil at different depths. Another result of the characterization survey was that, with the exception of vegetation, no biological samples obtained from the DU affected area (i.e., animals) showed any radiological evidence of DU contamination by virtue of both the magnitude of uranium concentration and the U-238/U-234 activity ratio (SEG 1996).

In summary, the radiological scoping and characterization surveys identified the specific areas within the JPG that are contaminated with DU and provided information on the extent of movement of uranium through the environment. The scoping survey identified a 125-acre (0.5 km^2) area within the potentially affected area as being DU contaminated. A common result of the scoping and characterization surveys was that soil samples collected in the immediate vicinity of or immediately below penetrators contained relatively high levels of DU, and soil samples not in the immediate vicinity of penetrators contained low or background levels of

uranium. In addition, surface water and wildlife samples contained background levels of radioactivity. These results indicate that residual contamination at the JPG is concentrated in a heterogeneous manner in trenches located along the three firing lines and that DU has been confined to the immediate vicinity of the penetrators.

2.3.2 ERM Program

The ERM program has been in place since 1983. For the period extending from 1983 to 1994, samples located on a judgmental basis have been collected at up to 58 soil, 11 groundwater, and 11 surface water and sediment locations. In addition, results from analysis of 17 vegetation and approximately 25 wildlife samples have been reported (Ebinger and Hansen 1996a).

Under the ERM program in effect prior to the issuance of this ERM Program Plan, 4 soil, 11 groundwater, and 8 surface water and sediment locations were sampled at locations depicted in **Figure 2-1**. The four soil locations are at the corners of the DU Impact Area. Groundwater samples were collected at the same locations as those of the scoping and characterization surveys. Four surface water samples were collected on Big Creek, three in the DU Impact Area, and one at the west perimeter fence. Four surface water samples were also collected on Middle Fork Creek, one at the southeastern corner of the DU Impact Area, two in the firing line area, and one at the west perimeter fence. Sediment samples were collected at the same locations as the surface water samples.

In addition to development of reports on individual sampling events, assessments of the historical data are presented in various documents (Abbott 1988; U.S. Army 1986; Ebinger and Hansen 1996a and b; and U.S. Army 2002a and b). In support of development of this update to the 2000 Standard Operating Procedure (U.S. Army 2000a), a trend analysis of the historical data was completed. The results of this analysis are presented in Appendix A and discussed in Section 3 of this ERM Program Plan.

2.3.3 Regional Range Study

A limited focus investigation of the potential chemical impact of live-fire training operations at JPG was completed (CHPPM 2003). Sampling of soils, surface water, sediment, groundwater, vegetation, and the sperm of a limited number of small mammals was conducted to support screening level human and ecological risk assessments. Sampling locations for groundwater and soil included the DU Impact Area. Surface water and sediment sampling occurred at the entrance and exits points of the installation. Among the analytes assessed in the study was uranium in groundwater, soil, surface water, and sediment.

The study concluded the following:

- Environmental Media
  - ***Groundwater*** – Groundwater sample results indicated no evidence of groundwater contamination from the past use of munitions or the presence of UXO in the study area. Total uranium was detected at concentrations below the maximum concentration limit (MCL) of 30 microgram per liter (µg/L). Filtered sample concentrations ranged from 0.2544 to 21.4 µg/L. The U-235/U-238

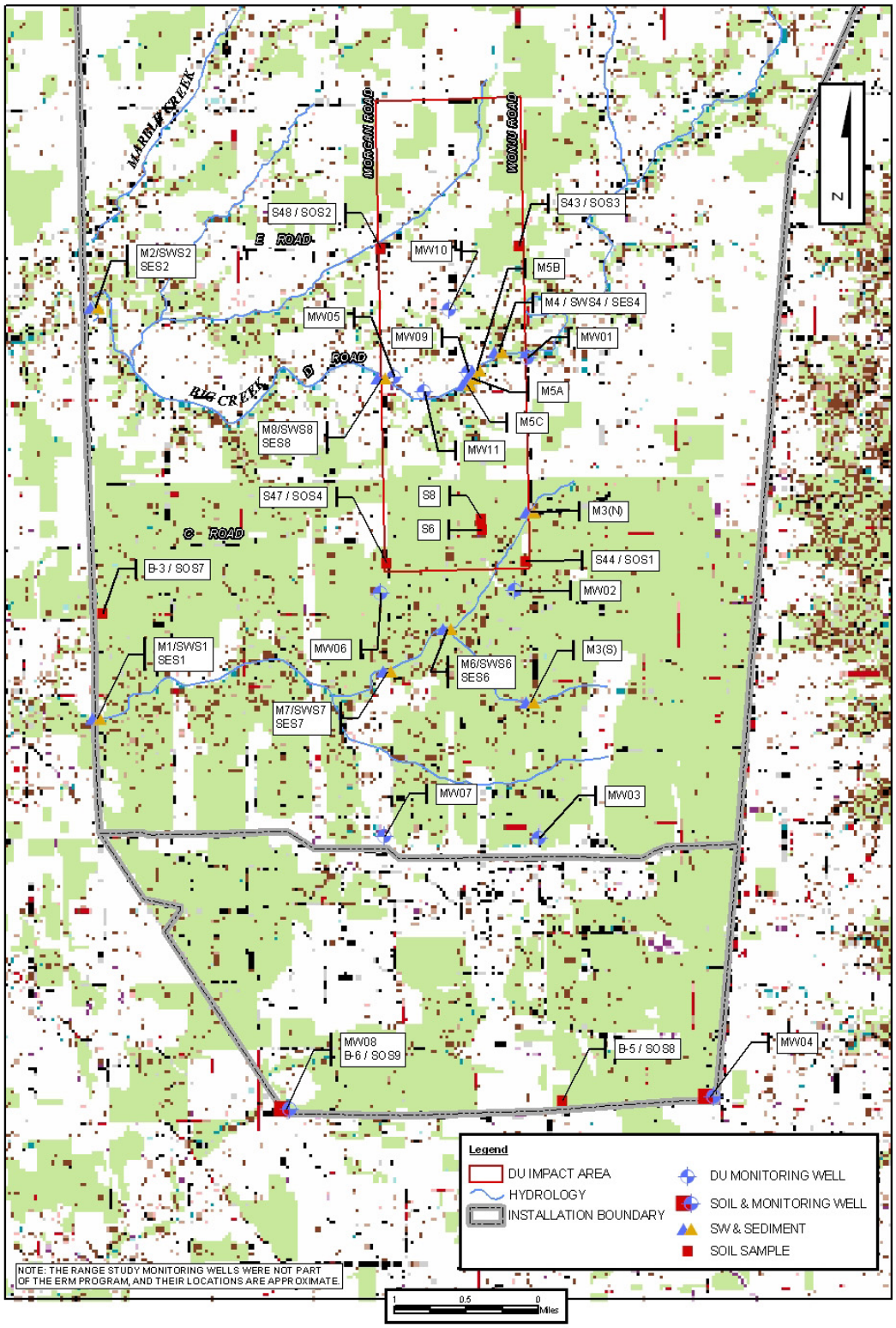

Figure 2-1. Sampling Locations Under the ERM Program (U.S. Army 2000a)
Jefferson Proving Ground, Indiana

uranium concentration ratio in all filtered samples, except for MW-11, does not indicate the presence of DU. The U235/U238 ratio at this sample location is less than the 0.000720 criterion; however, the measurement uncertainty is greater than 0.0001, indicating that this sample result may not be positive.[1]

- ***Soils*** – Uranium was detected at an average of 6.5 and 2.35 mg/kg in the two study areas within the DU Impact Area. The maximum uranium concentration was 45.8 mg/kg (99th percentile). None of the detections exceeded the health based risk criterion of 200 mg/kg.

- ***Surface Water, Sediments, and Benthic Invertebrates*** – Results of surface water, sediment, and benthic macroinvertebrate sampling at JPG indicated that with few exceptions, total and dissolved uranium concentrations in surface water were below reference values. In all but one instance, values were below Federal water quality criteria[2] for uranium. Similarly, total uranium in sediment demonstrated a similar trend. Based on macro benthic sampling, organisms at sample locations did not differ from the reference sites and no adverse effects were observed.

- Risk Assessments

  - ***Human Health Risk*** – The substances of potential concern (SOPCs) detected in both surface water and soil within the former range area (which included uranium) would not present a health risk to onsite workers or recreational users (hunters). All of the exposure point concentrations evaluated were well below the calculated site-specific screening levels.

  - ***Ecological Risks*** – Based on the weight of evidence obtained, the small mammal population was determined not to be affected by the SOPCs (which included uranium) attributable to range operations.

[1] A U235/U238 uranium ratio of 0.00720 or less and within a measurement uncertainty of + 0.0001 is indicative of the presence of DU contamination.

[2] Federal ambient water quality criteria for uranium are 46 µg/L and 2.6 µg/L for the criteria maximum concentration (CMC) and criteria continuous concentration (CCC), respectively. The CMC and CCC values will protect against acute and chronic effects in aquatic life, respectively.

3. ERM PROGRAM STRATEGY AND PLAN

In this section, the ERM program strategy and plans are presented. The overall goals of the program are presented (Section 3.1), followed by the presentation of the data quality objectives (DQOs) (Section 3.2). For each environmental medium, the rationale and basis for sampling is presented, including action levels and associated procedures if the action levels are exceeded (Section 3.3).

3.1 ERM GOALS AND RATIONALE

The overall goals of the ERM program at JPG are to provide:

- A historical and current perspective of contaminant levels in various media
- An indication of the magnitude and extent of any DU release or migration from past operations
- A timely indication of DU contaminant release and migration.

Environmental monitoring activities are necessary at JPG to ensure that DU within the DU Impact Area does not pose a threat to human health and the environment through inadvertent or unanticipated release or migration. These monitoring activities include the surveillance of all credible transport pathways; the selection of suitable surveillance locations; and the application of appropriate sampling methods, techniques, and analyses. To achieve this goal, the program has been designed to meet the applicable requirements of applicable Federal and State regulations, including NRC regulations and requirements for License SUB-1435.

Because the radioactive material is isolated within the DU Impact Area and institutional controls are in place to prevent and control access to the area, exposure is not likely to occur. However, migration of this material through groundwater, surface water, soil, stream bed sediments, air, and biota is possible. The JPG ERM program was developed to provide direct surveillance of the most probable migration routes through periodic sampling and analysis of radioactive constituents. The following sections present the DQOs for this ERM program and discuss the rationale for the selection of the probable migration routes, sampling locations and frequencies, and action levels and associated steps to be taken if the action levels are exceeded.

3.2 DATA QUALITY OBJECTIVES

The DQO process is a scientific data collection planning process designed to ensure that the type, quality, and quantity of data collected are appropriate for environmental decision-making. It consists of seven prescribed steps outlined in "Data Quality Objectives Process for Hazardous Waste Site Investigations" (U.S. Environmental Protection Agency [EPA] 2000). DQOs define the purpose of the data collection effort, clarify what the data should represent to satisfy this purpose, and specify the performance requirements for the quality of information to be obtained from the data. These outputs then are used in the final step of the DQO process to develop a data collection design that meets all requirements and constraints.

The DQO process for the ERM program applies to the DU Impact Area at JPG and consists of the following elements corresponding to steps in the DQO process:

- The primary objective for environmental sample collection at JPG is to provide data of known and sufficient quality to determine if conditions have changed since the previous sampling events. The data will help define the nature and extent (horizontal and vertical) of DU contaminant migration if it occurs (***DQO Step 1 – State the Problem***).

- The environmental sampling will provide field measurements and analytical data sufficient to determine if DU contamination from the DU Impact Area is migrating to the groundwater or other areas of JPG. The data will be used to support the development and selection of appropriate corrective actions if required (***DQO Step 2 – Identify the Decision***).

- ERM data from previous and current sampling events at JPG, along with data from the scoping and characterization surveys and other related studies, will provide additional inputs to meet the objectives (***DQO Step 3 – Identify Inputs to the Decision***).

- The boundaries of the DU Impact Area are depicted in **Figure 2-1** (***DQO Step 4 – Define the Study Boundaries***).

- Contaminant concentrations at JPG ERM sampling locations will be compared with the concentrations detected in appropriate background media and specified in Federal regulations or defined in this ERM Program Plan to determine the extent of contamination migration at JPG (***DQO Step 5 – Develop a Decision Rule***).

- The sample analysis and validation will be performed in general accordance with the procedures contained in the QAPP (***DQO Step 6 – Specify Limits on Decision Errors***).

- The groundwater, surface water, and sediments will be sampled annually to provide sufficient data concerning contaminant concentrations and potential migration. Sampling results will be used to determine if there have been changes in contaminant trends or potential groundwater flow directions and gradients since the previous sampling event (***DQO Step 7 – Optimize the Design for Obtaining Data***).

3.3 RADIATION MONITORING STRATEGY AND PLANS

In this section, the rationale and plans for monitoring environmental media (i.e., groundwater, surface water, sediment, soil, air, and biota) are presented. **Table 3-1** summarizes the ERM program, including planned monitoring activities by environmental medium and associated action levels.

Table 3-1. ERM Program Plan: Monitoring Plans and Associated Action Levels Jefferson Proving Ground, Indiana

Environmental Medium	Monitoring Plan	Action Levels and Related Actions	
		Action Level (Unit)	Action
Groundwater	***Frequency:*** Annual ***Monitoring Plan:*** Well sampling of where increasing DU concentrations are indicated (MW-3 and MW-4) and sampling of 50% of the remaining nine wells using a random lottery selection process.	20 pCi/L	• If groundwater analytical results at any well exceed 50% of the limit (i.e., 10 pCi/L), the U.S. Army's SBCCOM will conduct an independent assessment of the results and any trends indicated by the ERM program. Additional sampling may be performed based on U.S. Army review of the results and associated recommendations. • If groundwater analytical results at any well exceed the action level limit of 20 pCi/L, the U.S. Army's SBCCOM will notify the U.S. Army Materiel Command and the NRC within 7 calendar days of receipt of analytical sampling results. Additional sampling will be performed within 30 calendar days of the U.S. Army's receipt of the analytical results. Further actions may be defined based on the results of confirmatory sampling.
Surface Water	***Frequency:*** Annual ***Monitoring Plan:*** This plan includes annual sampling of the exit points of the Big Creek and Middle Creek and 50% of the remaining six surface water monitoring points using a random lottery selection process.	300 pCi/L	• If surface water analytical results from any sample location exceed 50% of the limit (i.e., 150 pCi/L), the U.S. Army's SBCCOM will conduct an independent assessment of the results and any trends indicated by the ERM program. Additional sampling may be performed based on U.S. Army review of the results and associated recommendations. • If surface water analytical results exceed the action level of 300 pCi/L, the U.S. Army's SBCCOM will notify the U.S. Army Materiel Command and the NRC within 7 calendar days of receipt of analytical sampling results. Additional sampling will be performed within 30 calendar days of the U.S. Army's receipt of the analytical results. Further actions may be defined based on the results of confirmatory sampling.
Sediment	***Frequency:*** Annual ***Monitoring Plan:*** Sampling of the exit points of the Big Creek and Middle Creek and 50% of the remaining six sediment monitoring points using a random lottery selection process.	94 pCi/g	• If analytical results of sediment exceed 50% of the limit (i.e., 46 pCi/g), the U.S. Army's SBCCOM will conduct an independent assessment of the results and any trends indicated by the ERM program. Additional sampling may be performed based on U.S. Army review of the results and associated recommendations. • If analytical results for a sediment sample are greater than 94 pCi/g, the U.S. Army's SBCCOM will notify the U.S. Army Materiel Command and the NRC within 7 calendar days of receipt of analytical sampling results. Additional sampling will be performed within 30 calendar days of the U.S. Army's receipt of the analytical results. Further actions may be defined based on the results of confirmatory sampling.

Table 3-1. ERM Program Plan: Monitoring Plans and Associated Action Levels Jefferson Proving Ground, Indiana (Continued)

Environmental Medium	Monitoring Plan	Action Levels and Related Actions	
		Action Level (Unit)	Action
Soil	No monitoring plan baselined[a]	NA	NA
Air	No monitoring plan baselined[a]	NA	NA
Biota	No monitoring plan baselined[a]	NA	NA

[a] Subject to change based on evidence of significant changes in the status of DU contamination at the site as well as at the 5-year review (see Section 7).

ERM = Environmental Radiation Monitoring

NA = not applicable

pCi/g = picocuries per gram

pCi/L = picocuries per liter

NRC = Nuclear Regulatory Commission

MW = monitoring well

SBCCOM = Soldier and Biological Chemical Command

3.3.1 Groundwater

In support of this analysis, historical data for groundwater in the vicinity of the DU Impact Area were reviewed. Based on the results of this analysis (Appendix A), the plans for environmental monitoring were developed (Section 3.3.1.1). Procedures for followup actions are defined for the action levels specified in Section 3.3.1.2.

3.3.1.1 Rationale for Groundwater Monitoring

Onsite and offsite human and ecological receptors could be impacted by DU leaching through soil to the underlying aquifer. Contaminated groundwater can enter the human or ecological food chain indirectly (e.g., livestock drinking water) or directly (e.g., drinking water supply). Direct exposure of humans to drinking water is unlikely given that the aquifer is not a drinking water source and is of poor quality (Rust 1998).

The scoping and characterization surveys (SEC Donahue 1992; SEG 1995a and b; SEG 1996; and U.S. Army 2002a and b) and the ongoing ERM program provide a historical database to evaluate the DU concentrations in the groundwater and associated trends. Overall, the data indicate variations in the concentration of uranium in wells since 1984, the largest of which is attributable to errors in sample handing (U.S. Army 2002a and b; Ebinger and Hansen 1996a and b). Furthermore, data indicate that DU contamination has not moved to the groundwater or surface water from the DU Impact Area. Finally, the results of a comprehensive groundwater sampling of 7 of the 11 existing wells plus 8 additional wells in the DU Impact Area indicate that total and dissolved uranium concentrations neither exceeded MCLs (or health advisory criteria) nor presented risks to onsite receptors based on site-specific, risk-based screening values (CHPPM 2003).

As indicated in the preceding discussion, historical ERM data were reviewed and a trend analysis was performed to support plans for future monitoring of this medium (Appendix A). An expanded sampling program is not warranted at this time given that no discernable pattern, except for MW-3 and MW-4, is evident and concentrations of uranium are well below the action level of 20 pCi/L (see Section 3.3.1.2). As Appendix A indicates, there is an increasing trend for groundwater monitoring wells MW-3 and MW-4 (see **Figure 2-1**) and a decreasing trend for the remaining wells. All results were below the action level presented in Section 3.3.1.2.

Adverse health effects from DU radiation to onsite or offsite human receptors are predicted to be low and are the smallest of risk factors, based on predictions of risk models (e.g., Ebinger and Hansen 1996b; and U.S. Army 2002a) and site-specific risk-based screening assessments (CHPPM 2003).

The historical data, trend analysis, and results of human health and environmental risk assessments of the effects of DU contamination cited above were used to formulate this monitoring plan for groundwater. This plan includes annual sampling of the wells exhibiting increasing trends (MW-3 and MW-4) and sampling 50 percent of the remaining nine wells using a random lottery selection process.

3.3.1.2 Groundwater Action Levels and Associated Procedures

The action level in the previous ERM program documentation (U.S. Army 2000a) was based on the water effluent release limits for uranium in 10 CFR 20, Appendix B, which is approximately 300 pCi/L. The 10 CFR 20, Appendix B, limits are not intended for use when assessing groundwater. The EPA drinking water standard uses an MCL for uranium of 30 µg/L and is more applicable for groundwater. The uranium MCL of 30 µg/l is converted into pCi/L using the specific activity of uranium, 0.68 pCi/µg. This conversion results in a concentration of approximately 20 pCi/L. The action level for groundwater is set at 20 pCi/L, which is considered a conservative value given that the aquifer at JPG is not and will not be a source of public water supply. Past analytical results from ERM sampling have not exceeded this value.

If groundwater analytical results at any well exceed 50 percent of the limit (i.e., 10 pCi/L), the U.S. Army's SBCCOM will conduct an independent assessment of the results and any trends indicated by the ERM program. Additional sampling may be performed based on U.S. Army review of the results and associated recommendations.

If groundwater analytical results at any well exceed the action level limit of 20 pCi/L, the U.S. Army's SBCCOM will notify the U.S. Army Materiel Command and the NRC within 7 calendar days of receipt of analytical sampling results. Additional sampling will be performed within 30 calendar days of the U.S. Army's receipt of the analytical results. Further actions may be defined based on the results of confirmatory sampling.

3.3.2 Surface Water

In support of this analysis, historical data for surface water in the vicinity of the DU Impact Area were reviewed. Based on the results of this analysis (Appendix A), the plans for environmental monitoring were developed (Section 3.3.2.1). Procedures for follow-up actions are defined or the action levels specified in Section 3.3.2.2.

3.3.2.1 Rationale for Surface Water Monitoring

Surface water can be contaminated by DU transported by water erosion as well as contaminated groundwater surfacing into ponds or streams. Contaminated surface water can enter the human food chain indirectly as livestock drinking water or directly through the drinking water supply, as discussed previously for groundwater. In addition, fish or other organisms indigenous to streams or ponds that contain contaminated water represent a pathway to potential receptors.

The scoping and characterization surveys and ongoing ERM program provide a historical database to evaluate the concentrations of DU in the surface water and associated trends. Scoping survey and characterization data (SEC Donahue 1992; SEG 1995a and b; SEG 1996; and U.S. Army 2002a and b) indicate that total uranium concentrations in surface water are well below the action level defined in Section 3.3.2.1 (300 pCi/L): the maximum concentration detected in these samples was 25 pCi/L. Results of the ERM program further verify these low concentrations (Ebinger and Hansen 1996a and b). These data also indicate that DU contamination has not moved to the surface water from the DU Impact Area.

Finally, the results of surface water (including sediment and benthic macroinvertebrate) sampling in 2002 from all significant creeks (entrance, exit, and midpoints), a total of 18 locations within six creeks, were used to determine if munitions compounds and firing range activities may have impacted surface water quality. The results indicated that with few exceptions, total and dissolved uranium concentrations in surface water were below their respective reference values. Benchmarks were exceeded for uranium in surface water and sediment in Big Creek, but the differences were not regarded as substantial. At one intermediate sampling point on the western border of the DU Impact Area, the uranium water quality criterion (i.e., CCC) of 2.6 μg/L was exceeded (4.1 μg/L); however, the total uranium concentration returned to background levels by the time Big Creek exited the installation. The maximum uranium concentration was 4.1 μg/L, which is equivalent to 2.8 pCi/L (based on the specific activity of uranium, 0.68 pCi/μg). In general, the results of this study provide further evidence that firing range activities (inclusive of DU operations) neither have impacted surface water significantly nor present a risk to human or ecological receptors (CHPPM 2003).

As indicated in the preceding discussion, historical ERM data were reviewed and a trend analysis was performed to support plans for future monitoring of surface water (Appendix A). The analysis addressed samples from 1998 to the present and indicated that all results were well below the action level of 300 pCi/L (see Section 3.3.2.2).

Adverse health effects from DU radiation to onsite or offsite human receptors are predicted to be low and are the smallest of risk factors, based on predictions of risk models (e.g., Ebinger and Hansen 1996b and U.S. Army 2002a) and site-specific risk-based screening assessments (CHPPM 2003).

The historical data, data analysis (1998–2002), and results of human health and environmental risk assessments of the effects of DU contamination cited above were used to formulate this monitoring plan for surface water. An expanded sampling program is not warranted at this time given the fact that no discernable patterns are evident and concentrations of uranium are well below the action level. This plan includes annual sampling of the exit points

of the Big Creek and Middle Creek and 50 percent of the remaining six surface water monitoring points using a random lottery selection process.

3.3.2.2 Surface Water Action Level and Associated Procedures

At 10 CFR 20, Appendix B, Table 2 provides annual concentration limits for airborne and liquid effluents released to the general environment. If ingested continuously over the course of a year, the water effluent concentrations listed in Table 2 would produce a total effective dose equivalent of 50 mrem. The effluent value for U-238 is 3E-7 μCi/ml, which is equivalent to approximately 300 pCi/L. This annual effluent limit for U-238 from Table 2 is the most appropriate for depleted uranium.

If surface water analytical results from any sample location exceed 50 percent of the limit (i.e., 150 pCi/L), the U.S. Army's SBCCOM will conduct an independent assessment of the results and any trends indicated by the ERM program. Additional sampling may be performed based on U.S. Army review of the results and associated recommendations.

If surface water analytical results exceed the action level of 300 pCi/L, the U.S. Army's SBCCOM will notify the U.S. Army Materiel Command and the NRC within 7 calendar days of receipt of analytical sampling results. Additional sampling will be performed within 30 calendar days of the U.S. Army's receipt of the analytical results. Further actions may be defined based on the results of confirmatory sampling.

3.3.3 Sediment

In support of this analysis, historical data for groundwater in the vicinity of the DU Impact Area were reviewed. Based on the results of this analysis (Appendix A), the plans for environmental monitoring were developed (Section 3.3.3.1). Procedures for follow-up actions are defined or the action levels specified in Section 3.3.3.2.

3.3.3.1 Rationale for Sediment Monitoring

Sediment can be contaminated by DU transported by surface water, water erosion, and contaminated groundwater flowing into ponds or streams. Contaminated sediment can enter the human food chain indirectly from incidental ingestion by livestock, fish, or game. In addition, biotic material adsorbing contaminants from the sediment also represent an indirect exposure route.

The scoping and characterization surveys and ongoing ERM program provide a historical database to evaluate the concentrations of DU in the sediment and associated trends. Scoping survey and characterization data (SEC Donahue 1992; SEG 1995a and b; SEG 1996; and U.S. Army 2002a and b) indicate that total uranium concentrations in sediment are well below the action level defined in Section 3.3.3.2 (94 pCi/g): the maximum total uranium concentration detected in these samples was 6.2 pCi/g. Results of the ERM program further verify these low concentrations (Ebinger and Hansen 1996a and b). These data also indicate that DU contamination has not migrated from the DU Impact Area.

Finally, the results of sediment (including surface water and benthic macroinvertebrate) sampling in 2002 from all significant creeks (entrance, exit, and midpoints), a total of 18 sites,

were used to determine if munitions compounds and firing range activities may have impacted surface water quality. The results indicated that with few exceptions, total uranium detections were below reference values. All of the exceedences were considered not substantial. The maximum concentration detected was 3.1 µg/g in Big Creek at the western border of the DU Impact Area, which is equivalent to 2.1 pCi/g based on a specific activity of 0.68 pCi/µg. The uranium sediment concentration returned to background levels once Big Creek exited JPG. In general, the results of this study provide further evidence that firing range activities (inclusive of DU operations) neither have impacted surface water significantly nor present a risk to human or ecological receptors (CHPPM 2003).

As indicated in the preceding discussion, historical ERM data were reviewed and a trend analysis was performed to support plans for future monitoring of sediment (Appendix A). The analysis addressed samples from 1998 to the present and indicated that all results were well below the action level of 94 pCi/g (see Section 3.3.2.2): the maximum uranium concentration detected was 3 pCi/g.

Adverse health effects from DU radiation to onsite or offsite human receptors are predicted to be low and are the smallest of risk factors, based on predictions of risk models (U.S. Army 2002a) and site-specific risk-based screening assessments (CHPPM 2003).

The historical data, data analysis (1998–2002), and results of human health and environmental risk assessments of the effects of DU contamination cited above were used to formulate this monitoring plan for sediment. An expanded sampling program is not warranted at this time given the fact that no discernable patterns are evident and concentrations of uranium are well below the action level. This plan includes annual sampling of the exit points of the Big Creek and Middle Creek and 50 percent of the remaining six sediment monitoring points using a random lottery selection process.

3.3.3.2 Sediment Action Levels

Sediment sampling will be performed in the same general area as surface water sampling. The source term recent dose assessments for the DU Impact Area (U.S. Army 2002a) are based on soil concentration of 94 pCi/g and 225 pCi/g, depending on the exposure scenario. The most conservative scenario (i.e., an onsite farmer with irrigation), using 94 pCi/g in the soil, results in a dose of less than 25 mrem/yr. Based on this conservatism, an action level of 94 pCi/g is recommended for sediment.

If analytical results of sediment exceed 50 percent of the limit (i.e., 46 pCi/g), the U.S. Army's SBCCOM will conduct an independent assessment of the results and any trends indicated by the ERM program. Additional sampling may be performed based on U.S. Army review of the results and associated recommendations.

If analytical results for a sediment sample are greater than 94 pCi/g, the U.S. Army's SBCCOM will notify the U.S. Army Materiel Command and the NRC within 7 calendar days of receipt of analytical sampling results. Additional sampling will be performed within 30 calendar days of the U.S. Army's receipt of the analytical results. Further actions may be defined based on the results of confirmatory sampling.

3.3.4 Soil

Soil ingestion also can be a significant environmental pathway with regard to dose estimates. Receptors can be exposed directly by incidental ingestion of DU-containing soil on vegetables or other food products that contact contaminated soil. Indirectly, contaminated soil can be ingested by livestock and passed to humans via poultry, pork, beef, and dairy product consumption.

The scoping and characterization surveys and ongoing ERM program provide a historical database to evaluate the concentrations of DU in the soil and associated trends. Scoping survey data (SEC Donahue 1992; SEG 1995a and b; SEG 1996; and U.S. Army 2002a and b) indicate that total uranium concentrations in soil were less than 2 pCi/g along trajectories and highest within the DU Impact Area, with an average concentration of approximately 13 pCi/g. Characterization data pointed to the highest total uranium concentrations confined to the top 15 cm of soil beneath penetrators at levels above a potential action level of 94 pCi/g (see Section 3.2.3.2) (SEG 1996 and U.S. Army 2002a and b).

Soil concentration data from the 1984 to 2000 ERM program are skewed left with a mean value of 18.8 pCi/g and a median value of 1.5 pCi/g; the standard deviation of these samples is almost 200 pCi/g. Of nearly 400 soil samples analyzed since 1984, most are less than 2 pCi/g, which is equivalent to the average background soil concentration of uranium at JPG. Similar distributions for DU concentrations in groundwater and surface water were obtained for the same period (Ebinger and Hansen 1996a and b). These data also indicate that DU contamination has not migrated from the DU Impact Area.

Finally, the results of random composite soil sampling in and surrounding the DU Impact Area during the Range Study indicated that uranium concentrations were not significantly greater than reference values and did not exceed the human health risk criterion. The highest concentration detected was at a sample location in the southern portion of the DU Impact Area. This value, 45.8 mg/kg, was well below the human health risk criterion of 200 mg/kg. The average uranium concentrations in the northern and southern study site DU Impact Areas were 2.3 mg/kg and 6.5 mg/kg, respectively. In general, the results provide further evidence that firing range activities (inclusive of DU operations) neither have impacted soil significantly nor present a risk to human or ecological receptors (CHPPM 2003).

As indicated in the preceding discussion, historical ERM data were reviewed to support plans for future monitoring of soil (Appendix A). The analysis, which addressed samples from 1998 to the present, indicated that with one exception in the year 1998 (SOS4), all results were well below a potential action level of 94 pCi/g (see Section 3.3.3.2).

Adverse health effects from DU radiation to onsite or offsite human receptors are predicted to be low and are the smallest of risk factors, based on predictions of risk models (e.g., Ebinger and Hansen 1996b; and U.S. Army 2002a) and site-specific risk-based screening assessments (CHPPM 2003).

The historical data, trend analysis, and results of human health and environmental risk assessments of the effects of DU contamination cited above were used to formulate these monitoring plan recommendations for soil. Further sampling of soil at these locations is not

recommended given that the sample locations were cleared of DU penetrators to support the ERM program; therefore, the value of sampling data from these surface soil samples is questionable. Historical sampling data verify this statement. Furthermore, additional soil sampling at other locations within the DU Impact Area is not recommended because of the UXO risks and additional costs associated with protection of field crews from UXO hazards and evidence that soil has not been impacted significantly from firing range activities (CHPPM 2003). This decision will be revisited if there are significant changes in the status of DU contamination at the site as well as at the 5-year review (Section 7).

3.3.5 Air

DU can be transported on the air through wind erosion or through smoke from fires. There are concerns about DU transport in the smoke that occurs during controlled burning at JPG and subsequent doses to receptors via this pathway. These annual events are of short duration (U.S. Fish and Wildlife Service [FWS] 2001).

There is some evidence that DU and other natural and anthropogenic radionuclides could be transported considerable distances and result in small doses to receptors due to physical disturbances (Kerekes et al. 2001; and Royal Society 2002a and b). Total radioactivity increased in smoke from fires related to battle (Royal Society 2002b), controlled burns, and wildfires (Williams et al. 1998; Johansen et al. 2001; and Kraig et al. 2001a and b), but the increased radionuclide concentrations did not result in significant doses to receptors. For example, Kraig et al. (2001a and b) showed that the estimated dose to firefighters at the scene of a fire that lasted several days was approximately 0.2 mrem, whereas the estimated dose to people away from the fire scene was approximately 0.06 mrem. These small increases in doses to various receptors were dominated by naturally occurring radioactive materials, such as uranium in soils and/or worldwide fallout (Kraig et al. 2001a; Kerekes et al. 2001; and Royal Society 2002b).

Williams et al. (1998) used atmospheric dispersion computer models to evaluate the potential for human health impacts from exposure to contaminants that could be dispersed by fires on testing ranges at Aberdeen Proving Ground. The screening level assessment does not estimate actual human health risks. One of the contaminants present in soil and vegetation as a result of past operations was DU. In this study, the computer plume model, FIREPLUME, was used to predict ground level concentrations resulting from releases of hazardous materials from a forest fire. The primary fire scenario was represented by a 100-m line source of fire occurring in 25 acres of either forest or grassland. Three classes of meteorological stability were considered (Classes A, D, and E). The maximum release concentration for DU was 6.58×10^{-5} milligrams per cubic meter (mg/m^3). This exposure level was four orders of magnitude lower than the non-carcinogenic air screening levels for an adult and child of 0.9 and 0.44 mg/m^3, respectively. The carcinogenic air screening level for DU was not calculated because it is known to be lower than the non-carcinogenic risk (Davis 1990).

Air monitoring was conducted in support of the ERM program in February 1984, April 1985, January 1986, and October 1987 and assessed in U.S. Army 1986 and Abbott 1988. This information was included in the Army's NRC Amendment 1 application (U.S. Army 1986) and Amendment 5 to License SUB-1435 (NRC 1989). Air sampling was completed at locations near the intersection of "C" Road, "D" Road, Wonju Road, and Morgan Road under worst case conditions

(during the dry season and burning events). There was not any detectable uranium in the samples. Both studies concluded that depleted uranium had not impacted this potential pathway to man.

These assessments indicate that risks associated with potential transport of DU in the air from controlled burns are negligible. The benefit/cost ratio of an air sampling program is extremely low (i.e., the benefits are small and the costs of the program high). An air monitoring program would have to include a robust database to capture a various meteorological conditions and site conditions to be valid. Therefore, an air monitoring program is not recommended given the low probability of DU release and transport and the negligible effects on receptors. This decision will be revisited if there are significant changes in the status of DU contamination at the site as well as at the 5-year review (Section 7).

3.3.6 Biota

DU may accumulate in vegetation and biological species if a release occurs. Ecological resources, therefore, may be impacted directly by exposures to DU or represent a direct or indirect exposure pathway to human receptors. Historical and recent sampling data for vegetation and biological specimens are summarized in Sections 3.3.6.1 and 3.3.6.1, respectively.

3.3.6.1 Vegetative Sampling

During the scoping survey (SEC Donahue 1992; and SEG 1995a and b), 20 vegetation samples were collected. Fourteen samples were obtained from within the DU Impact Area, and six samples were obtained along the firing line trajectories. The total uranium concentration in vegetation samples was less than 0.7 pCi/g in all samples. Two lichen samples from the south-central portion of the DU Impact Area had U-238 to U-234 activity ratios of 2.3 and 2.6, which indicate DU contamination.

During the characterization survey (SEG 1996), 10 vegetation samples of lichens, leaves, or grasses were collected from the affected area trenches. Samples were collected from the three penetrator fragment areas. Five vegetation samples were collected from Area 1, four samples from Area 2, and one sample from Area 3 and were analyzed for total uranium. Samples were washed with de-ionized (DI) water prior to analysis, and the wash water was analyzed separately from the vegetation sample to determine the amount of uranium on the surface of and in the sample. The total uranium concentration in vegetation samples ranged from 0.75 to 3,447 pCi/g, with an average concentration of 627.5 pCi/g. The total uranium concentration in the root wash samples ranged from 46.1 to 14,258 pCi/g, with an average concentration of 2,869 pCi/g. The U-238 to U-234 activity ratio ranged from 6.1 to 8.4, indicating the presence of DU contamination.

As part of the ERM program, vegetation and animal sampling was completed; however, the data set is not as complete as for the abiotic media. From the reported data, there does not appear to be an adverse impact on vegetation and animals. Little uranium, either natural or from DU, was detected in deer samples and raccoon and freshwater clam tissue. The results indicate that uranium can concentrate in vegetation but that this has not occurred on a widespread basis (Ebinger and Hansen 1996).

More recently, the range study (CHPPM 2003) included sampling vegetation. Fifty vegetative samples (wool grass and broomsedge) were collected and analyzed for heavy metals and explosives, including uranium. Uranium, among other heavy metals and explosives, was not detected from samples collected in the northern portion and southwest and northwest of the DU Impact Area. Risks to ecological receptors were not present from heavy metals or explosives.

3.3.6.2 Biological Sampling

Deer liver, kidney, and bone samples monitoring was conducted in support of the ERM program in 1984 and 1987 and assessed in U.S. Army 1986 and Abbott 1988. This information was included in the Army's NRC Amendment 1 application (U.S. Army 1986) and Amendment 5 to License SUB-1435 (NRC 1989). Both studies concluded that depleted uranium had not impacted this potential pathway to man.

During the characterization survey (SEG 1996), a total of eight biological samples were collected from deer, freshwater clams, fish, and a soft-shelled turtle. For three deer samples, concentrations of total uranium ranged from 0.09 to 0.42 pCi/g. For two samples of freshwater clams, concentrations of total uranium were 0.33 and 0.77 pCi/g. Concentrations of total uranium in fish and the turtle were below 0.25 pCi/g. The U-238 to U-234 activity ratio ranged from 0.4 to 1.2 and does not indicate the presence of DU contamination.

The range study (CHPPM 2003) assessed the impact of artillery firing activities using meadow voles. Sperm count, motility, and morphology of voles were characterized from 80 rodents captured from the same three areas used to collect vegetative samples. The results of the assessment are inconclusive because the observed abnormalities in sperm count and morphology were determined to be from factors other than chemical stressors. The observed differences among sites were below the benchmarks needed to cause a reproductive effect. The study concludes that the rodent populations are not being impacted negatively by SOPCs, which include uranium.

Historical and recent data indicate that DU is not accumulating in vegetative or biological specimens and that risks to ecological receptors from DU are negligible. The benefit/cost ratio of a biota sampling program is extremely low. Moreover, a biota sampling program is not recommended at this time given the low probability of DU release and insufficient evidence of bioaccumulation. This decision will be revisited if there are significant changes in the status of DU contamination at the site as well as at the 5-year review (Section 7).

4. PROJECT ORGANIZATION AND MANAGEMENT

The key organizations supporting the environmental monitoring program include the NRC, SBCCOM, and SAIC. Each of these organizations is described in Section 4.1. Section 4.2 defines the lines of authority for the key organizations. The roles and responsibilities for the ERM are defined in Section 4.3. Training requirements are addressed in Section 4.4.

4.1 RESPONSIBLE ORGANIZATIONS

This section identities and describes the roles of the key responsible organizations of NRC, SBCCOM, and contractors in implementing the ERM program.

4.1.1 Nuclear Regulatory Commission

NRC's primary mission is to protect the public health and safety and the environment from the effects of radiation from nuclear reactors, materials, and waste facilities. The NRC also regulates these nuclear materials and facilities to promote the common defense and security.

The NRC's regulatory function has five main components: (1) developing regulations and guidance for its applicants and licensees, (2) licensing or certifying applicants to use nuclear materials or operate nuclear facilities, (3) overseeing licensee operations and facilities to ensure that licensees comply with safety requirements, (4) evaluating operational experience at licensed facilities or involving licensed activities, and (5) conducting research, holding hearings to address the concerns of parties affected by agency decisions, and obtaining independent reviews to support regulatory decisions.

The NRC approves and oversees the implementation of JPG's License SUB-1435. Responsibilities include ensuring that the terms and conditions of JPG's license are being implemented, including the ERM program.

4.1.2 U.S. Army Soldier and Biological Chemical Command

SBCCOM's mission is to develop, integrate, acquire, and sustain soldier and nuclear, biological, and chemical defense technology, systems, and services and to provide for the safe storage, treaty compliance, and destruction of chemical materiel (see http://www.sbccom.army.mil/). In support of this mission, SBCCOM oversees NRC-issued licenses, such as JPG's License SUB-1435, and identifies and manages resources necessary to fulfill its licensing requirements.

The SBCCOM Safety Office coordinates with the NRC Headquarters and Region III and with other Federal and State agencies, such as the EPA Region 5, U.S. Fish and Wildlife Services (FWS), United States Air Force (USAF), Indiana Air National Guard (ANG), and Indiana Department of Environmental Management (IDEM).

4.1.3 Contractors

SAIC is a contractor to SBCCOM responsible for executing the ERM program at JPG. SAIC is responsible for planning, executing, and reporting on sampling events to SBCCOM using its team of technical and field personnel. Analytical laboratory services would be provided through a subcontracting arrangement with SAIC.

4.2 LINES OF AUTHORITY

As the license holder, SBCCOM has responsibility for oversight, development, and execution of its responsibilities for License SUB-1435 and the authority to assign and manage resources within its command to this project. As **Figure 4-1** indicates, SBCCOM reports to the U.S. Army Materiel Command. The key supporting organizations, the U.S. Army's CHPPM and Los Alamos National Laboratory, as well as contractors, report to SBCCOM.

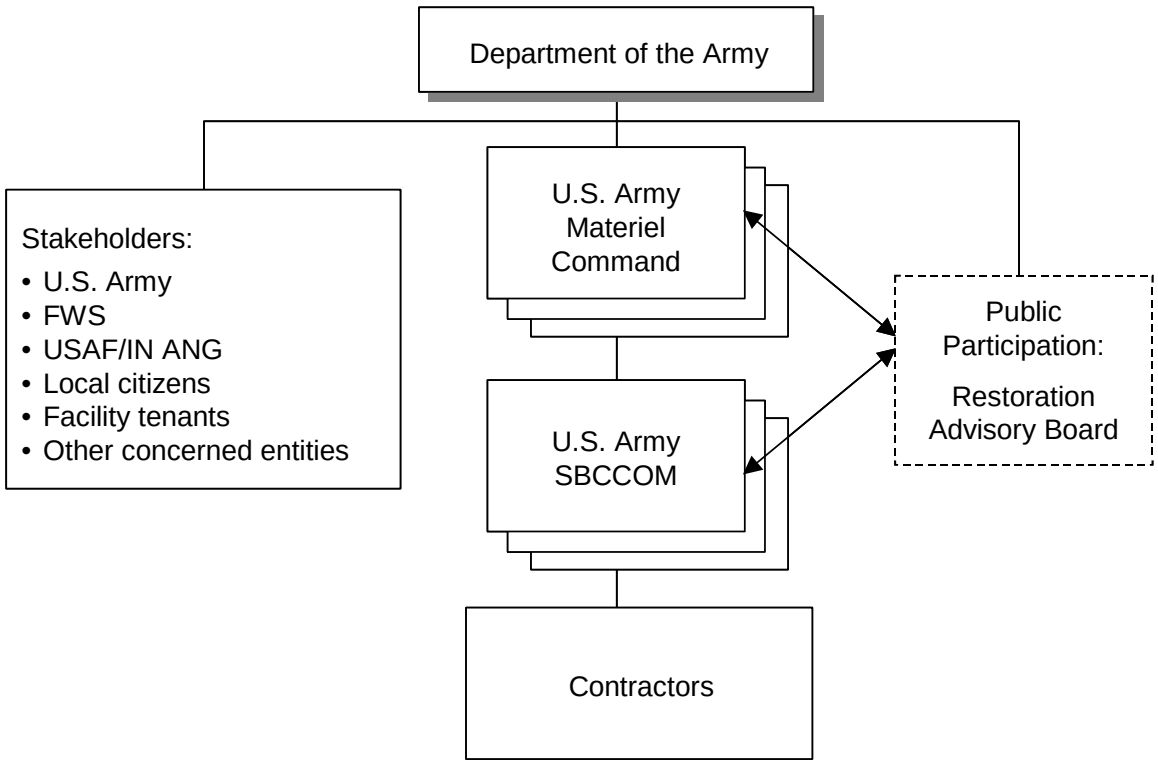

Figure 4-1. Chain of Command for the JPG ERM Program
Jefferson Proving Ground, Indiana

4.3 KEY MANAGEMENT POSITIONS

The roles and responsibilities of key organizations and key positions within these organizations that support the license termination process are described briefly in this section. **Table 4-1** lists the key organizations, positions, and contact information.

4.3.1 Soldier and Biological Chemical Command

Key positions within the U.S. Army's SBCCOM include the Radiation Protection Officer (RPO) and BRAC Environmental Coordinator. The RPO coordinates and addresses radiation safety issues. This individual also reviews monitoring data, conducts annual reviews and/or audits of site activities or related policies, and recommends corrective actions, as required, to the SBCCOM.

The BRAC Environmental Coordinator manages environmental restoration activities at the installation. This individual is responsible for identifying BRAC closure requirements and implementing related measures to ensure that the site closeout process is achieved.

Table 4-1. Key Organizations, Positions, and Contact Information for the Environmental Radiation Monitoring Program
Jefferson Proving Ground, Indiana

Organization	Position	Contact Information
SBCCOM	Radiation Protection Officer	Joyce Kuykendall (410) 436-7118 joyce.kuykendall@sbccom.apgea.army.mil
SBCCOM	BRAC Environmental Coordinator	Paul Cloud (410) 436-2381 pdcloud@sbccom.apgea.army.mil
SBCCOM	Site Manager	Ken Knouf (812) 273-2551 jpg@seidata.com
SAIC	Project Manager	Corinne Shia (703) 318-6993 corinne.m.shia@saic.com
SAIC	QA/QC Manager	Steve Howard (314) 770-3059 steve.c.howard@saic.com
SAIC	Health Physicist	Mark Peterson (314) 770-3053 mark.a.peterson@saic.com
SAIC	Site Safety and Health Officer	Mark Peterson (314) 770-3053 mark.a.peterson@saic.com
SAIC	Field Manager	Michael Cox (256) 236-1370 michael.h.cox@saic.com

BRAC = Base Realignment and Closure
SBCCOM = Soldier and Biological Chemical Command
SAIC= Science Applications International Corporation
QA/QC=Quality Assurance/Quality Control

The Site Manager is responsible for coordinating the onsite requirements for the ERM program, including arranging for site access, arranging for appropriate safety briefings, and coordinating with SBCCOM.

4.3.2 Contractor (SAIC)

The Project Manager is the overall lead for SAIC's support to SBCCOM. This individual is responsible for project planning, control, monitoring, and completion of all technical deliverables. The QA/QC Manager is responsible for leading radiological analytical activities and coordinating with analytical laboratories and for completing data quality assessments and audits. The Health Physicist is responsible for ensuring that the ERM program complies with radiological procedures for protection of field personnel and oversees the QA/QC Manager's

activities. The Site Safety and Health Officer is responsible for ensuring that the ERM program operates in compliance with all Federal and corporate environmental, health, and safety rules. The Field Manager is responsible for planning, conducting, and reporting on field activities described in this ERM Program Plan.

5. FIELD PROGRAM

In this section, the procedures associated with the field program are detailed. In particular, the protocol for sampling, sample handling and management, field measurements, equipment decontamination, and waste management are detailed. Quality assurance (QA) and site safety and health policy and procedures are addressed separately in Appendices B and C, respectively.

5.1 SAMPLING PROTOCOL

Procedures associated with planning and conducting sampling of the DU Impact Area are defined in this section. These procedures include pre-mobilization activities and environmental media sampling, field measurements, equipment decontamination, and waste management.

5.1.1 Pre-Mobilization Activities

The SBCCOM RPO will notify and coordinate with the SAIC Project Manager and Field Manager 60 days prior to the sampling date. The SBCCOM RPO will contact the JPG Site Manager to ensure that support will be onsite at the time of sampling. At this time, orders for supplies and instruments will be made. In addition, the arrangements with the analytical laboratory will be completed to support analysis of samples.

Proposed sample locations will be specified (see Section 3) and presented to SBCCOM prior to mobilization. Selection of some samples will be by a random lottery selection process.

5.1.2 Groundwater Sample Collection

Of the total 11 monitoring wells, 2 will be sampled (MW-3 and MW-4) because of historical trends in uranium concentrations. Five additional wells will be sampled based on a random lottery system. Therefore, the total number of wells to be sampled is seven. Existing wells are indicated on the groundwater sample map (**Figure 2-1**) using an alphanumeric code containing the letters MW and a two-digit sample number. **Table 5-1** identifies the analytical method and total number of water analyses.

Table 5-1. Analytical Method and Total Number of Groundwater Analyses
Jefferson Proving Ground, Indiana

Parameter/Analytical Method	Detection Limit (pCi/L)	Number of Analyses	Trip Blanks[a]	Duplicate Samples[b]	Equipment Rinsates[c]	MS/ MSDs[e]	Total Analyses[d]
Total Dissolved Uranium/ Fluorometric Analysis[f]	1 pCi/L	7	1	1	1	1	11

[a] Trip blanks are collected every 24 hours that water samples are collected.

[b] One field duplicate sample will be collected for every 10 or fewer water samples collected.

[c] One equipment rinsate blank will be prepared every 24 hours that samples are collected.

[d] In addition, one set of field blanks will be collected at the start of sampling.

[e] Matrix spike/matrix spike duplicate (MS/MSD) pairs of samples will be collected for every 20 samples of similar matrix received at the laboratory (10%).

[f] Method ASTM D5174 or equivalent.

pCi/L = picocuries per liter

Standard operating procedures for groundwater sampling are enumerated:

1. The purging of wells will be accomplished using a submersible pump. Upon opening each well, the well cover and wellhead will be inspected for damage, and organic vapors will be monitored using a photoionization detector (PID). The static water level then will be determined using a water level indicator probe. Immediately after the water level measurement, the pump intake will be installed approximately 1 foot below the top of the water surface. Each well will be purged at a rate no greater than the recharge rate of the aquifer. The water level should be monitored during purging to ensure that drawdown is not occurring. The field parameters of hydrogen ion concentration (pH), temperature, conductivity, and turbidity will be monitored and recorded during purging using a Horiba U-10 Water Quality Meter. Purging will be complete after the indicator parameters have stabilized within the following ranges over three consecutive readings:

   - pH = 0.2 pH units
   - Temperature = 1 degree Celsius (ºC)
   - Conductivity = 10 percent.

2. The sampler will don new nitrile or similar gloves.

3. Samples will be collected using a new hand bailer tied with new colorless twine for each sample. Care will be taken when lowering the bailer into the well to prevent unnecessary aeration or contamination of the sample.

4. A total quantity of 1 U.S. gallon of water will be collected.

5. A portion of the first bailer full of water will be placed into a clean beaker or other suitable container, and an evaluation of radiation level, temperature, pH, and conductivity will be conducted and recorded.

6. Sample information will be recorded on the Groundwater Sample Collection Worksheet (**Table 5-2**).

7. The sample will not be filtered or preserved in the field.

8. The sample will be wiped clean so that a label and security seal may be placed on it. The sample then will be placed into a sealed Ziploc bag prior to insertion into a cooler with ice.

   Additional forms may be used to record additional well information (e.g., well depth, purging data).

5.1.3 Surface Water Sample Collection

A total of eight sample locations are available for sampling (**Figure 2-1**). Based on the sampling strategy defined in Section 2, the exit points of the two creeks that run through the DU Impact Area (Big Creek and Middle Fork Creek), M1 and M2, will be sampled. In addition, 50 percent of the remaining sample locations (six) will be sampled based on a random lottery system. Therefore, the total samples to be collected are five.

Table 5-2. Groundwater Sample Collection Worksheet for the ERM Program Jefferson Proving Ground, Indiana

GROUNDWATER SAMPLES						
				Comments		
Sample ID	Sample Date	Exposure Reading (μR/hr)	Sample Locations	pH	Temp (°C)	Conductivity (MHOS)
MW01			Well at D-Road and Wonju Road (perimeter DU Impact Area)			
MW02			Well between C-Road and Wonju Road (perimeter DU Impact Area)			
MW03			Well between A-Road and gate on Wonju Road (perimeter DU Impact Area)			
MW04			Well on South Perimeter Road (along south border of JPG)			
MW05			Well at D-Road and Morgan Road (across Bridge No. 13) perimeter DU Impact Area			
MW06			Well at C-Road and Morgan Road (perimeter DU Impact Area)			
MW07			Well at Oakdale School House on Morgan Road (perimeter DU Impact Area)			
MW08			Well at Southwest Corner of JPG (Along south border of JPG)			
MW09			Well at D-Road and Bridge No. 22 (inside DU Impact Area)			
MW10			Well on Center Recovery Road (inside DU Impact Area)			
MW11			Well on D-Road between Morgan and C Recovery Road (inside Impact Area)			
MW12			Duplicate or Split Sample			

°C = degrees Celsius
DU = depleted uranium
ID = identification
JPG = Jefferson Proving Ground
MHOS = ohm^{-1}
μR/hr = microroentgens per hour
MW = monitoring well
pH = hydrogen ion concentration

Table 5-3 identifies the analytical method and total number of water analyses.

Table 5-3. Analytical Method and Total Number of Surface Water Analyses Jefferson Proving Ground, Indiana

Parameter/Analytical Method	Detection Limit (pCi/L)	Number of Analyses	Trip Blanks[a]	Duplicate Samples[b]	Equipment Rinsates[c]	MS/ MSDs[e]	Total Analyses[d]
Total Dissolved Uranium/ Fluorometric Analysis[f]	1 pCi/L	5	1	1	1	1	9

[a] Trip blanks are collected every 24 hours that water samples are collected.

[b] One field duplicate sample will be collected for every 10 or fewer water samples collected.

[c] One equipment rinsate blank will be prepared every 24 hours that samples are collected.

[d] In addition, one set of field blanks will be collected at the start of sampling.

[e] Matrix spike/matrix spike duplicate (MS/MSD) pairs of samples will be collected for every 20 samples of similar matrix received at the laboratory (10%).

pCi/L = picocuries per liter

Standard operating procedures for surface water sampling are enumerated:

1. The sampler will don clean nitrile or similar gloves.

2. Samples will be collected in new sample containers using the grab method. Sample containers will be positioned pointing upstream and below the surface of the water.

3. A sample quantity of 1 U.S. gallon of water will be collected.

4. Radiation dose rate measurements will be taken at 1 m above the sample location and recorded on the Surface Water Sample Worksheet (**Table 5-4**).

5. Water samples will not be filtered or preserved in the field.

6. The sample will be wiped clean so that a label and security seal may be placed on it. The sample then will be placed into a sealed Ziploc bag before being put into a cooler with ice.

5.1.4 Sediment Sample Collection

A total of eight sample locations are available for sampling (**Figure 2-1**). Based on the sampling strategy defined in Section 2, the exit points of the two creeks that run through the DU Impact Area (Big Creek and Middle Fork Creek), M1 and M2, will be sampled. In addition 50 percent of the remaining sample locations (six) will be sampled based on a random lottery system. Therefore, the total samples to be collected are five.

Table 5-5 identifies the analytical method and total number of water analyses.

Table 5-4. Surface Water Sample Worksheet for the ERM Program
Jefferson Proving Ground, Indiana

SURFACE WATER SAMPLES				
Sample ID	**Sample Date**	**Exposure Reading (μR/hr)**	**Sample Locations**	**JPG ID Code**
SWS1			West Perimeter Road Middle Fork Creek(exits JPG property)	SWBS (M1)
SWS2			Big Creek(exits JPG property)	SWBN (M2)
SWS3			Wonju Road Middle Fork Creek(enters DU Impact Area)	SWSE (M3)
SWS4			Big Creek(enters DU Impact Area)	SWNE (M4)
SWS5			Bridge No. 22 Big Creek	SWM (M5)
SWS6			Line of Fire Middle Fork Creek	SWS (M6)
SWS7			Bridge No. 12 at Morgan Road Middle Fork Creek	SWSW (M7)
SWS8			Bridge No. 13 at Morgan Road Big Creek	SWNW (M8)
SWS9			Duplicate or Split of SWS_	SWNE (M4)

ID= identification

DU = depleted uranium

JPG = Jefferson Proving Ground

μR/hr = microroentgens per hour

Table 5-5. Analytical Method and Total Number of Sediment Analyses
Jefferson Proving Ground, Indiana

Parameter/Analytical Method	Detection Limit (pCi/g)	Number of Analyses	Trip Blanks[a]	Duplicate Samples[b]	Equipment Rinsates[c]	MS/ MSDs[e]	Total Analyses[d]
Total Uranium or Thorium-234/ Gamma Spectroscopy	2 pCi/g	5	1	1	1	1	9

[a] Trip blanks are collected every 24 hours that water samples are collected.
[b] One field duplicate sample will be collected for every 10 or fewer water samples collected.
[c] One equipment rinsate blank will be prepared every 24 hours that samples are collected.
[d] In addition, one set of field blanks will be collected at the start of sampling.
[e] Matrix spike/matrix spike duplicate (MS/MSD) pairs of samples will be collected for every 20 samples of similar matrix received at the laboratory (10%).
pCi/L = picocuries per liter

Standard operating procedures for sediment sampling are enumerated below:

1. The sampler will don clean nitrile or similar gloves.

2. Samples will be collected using a new or properly cleaned scoop, trowel, or other suitable tool. Samples will be placed in a glass sample jar.

3. Sediment samples will be collected only after the water sample has been collected.

4. Although a sediment sample is usually considered a soil sample matrix, a certain amount of water is expected in the sample. The sample should not be drained of water that is not collected as part of the sample.

5. Radiation dose rate measurements will be taken at 1 meter above the sample location and recorded on the Sediment Sample Worksheet (**Table 5-6**).

6. The sample will be wiped clean so that a label and security seal may be placed on it. The sample will then be placed into a sealed Ziploc bag before being put into a cooler with ice.

Table 5-6. Sediment Sample Worksheet for the ERM Program Jefferson Proving Ground, Indiana

SEDIMENT SAMPLES				
Sample ID	**Sample Date**	**Exposure Reading (μR/hr)**	**Sample Locations**	**JPG ID Code**
SES1			West Perimeter Road Middle Fork Creek(exits JPG property)	(M1)
SES2			Big Creek(exits JPG property)	(M2)
SES3			Wonju Road Middle Fork Creek(enters DU impact area)	(M3)
SES4			Big Creek(enters DU impact area)	(M4)
SES5			Bridge No. 22 Big Creek	(M5)
SES6			Line of Fire Middle Fork Creek	(M6)
SES7			Bridge No. 12 at Morgan Road Middle Fork Creek	(M7)
SES8			Bridge No. 13 at Morgan Road Big Creek	(M8)
SES9			Duplicate or Split of SES_	(M4)

ID= identification

DU = depleted uranium

JPG = Jefferson Proving Ground

μR/hr = microroentgens per hour

5.2 SAMPLE HANDLING AND MANAGEMENT

Because samples collected are in support of NRC license commitments, chain of custody (COC) procedures will be followed. Samples will be secured from unauthorized access during the period of sampling. Prior to shipment of samples to the analytical laboratory, a properly completed COC Record will be placed in each shipping container. Survey personnel will maintain a copy of the COC Record (**Table 5-7**) for verification of sample transport. Water samples must reach the analytical laboratory no later than 4 days from the time of sampling. To ensure that this schedule is met and that the laboratory has time to filter and preserve the samples if necessary, water samples should be collected on the first day of the sampling trip and shipped the following day. It is not necessary to ship the water, sediments, and soils together.

Table 5-7. Chain-of-Custody (COC) Record
Jefferson Proving Ground, Indiana

Science Applications International Corporation
An Employee-Owned Company

PO #: **COC #:**

SAMPLING EVENT / PROJECT NAME:

Chain of Custody Record

PHONE NUMBER:
CONTACT NAME:
DATA REVIEWER:
LABORATORY:
ADDRESS:

REQUIRED TAT *(circle one):* **30hr** **5days** **15days** **30days**

Requested Analyses

Page ____ of _____

# of containers this page:

Sample ID #	Station	Date	Time	Depth/Flow/Vol.	Matrix											Comments

Special Instructions/
Comments:

Relinquished By:	Date:	Time:	Received By:	Date:	Time:

Sample analysis of all environmental samples will be performed through the analytical laboratory. Samples will be managed and analyzed in accordance with the established protocols and procedures of the analytical laboratory.

Water samples will be analyzed fluorometrically for dissolved total uranium. Soil and sediment samples will be analyzed using gamma spectroscopy, keying on the isotopic peaks of Thorium-234. Thorium 234 is the daughter of U-238 and is considered to be in equilibrium; therefore, the activity would be equivalent. The QA/QC for laboratory instruments will be performed by the analytical laboratory. Reports of analysis will be forwarded to SAIC for review. Electronic as well as hard copy reports will be provided.

5.2.1 Sample Containers

The analytical laboratory will provide sample containers and labels prior to the sampling event. Sample bags, labels, and coolers will be shipped to the following address:

U.S. Army
Jefferson Proving Ground
Attention: Ken Knouf
1661 West J.P.G. Niblo Road, Bldg. 125
Madison, IN 47250
(812) 273-2551

5.2.2 Sample Volumes, Types, and Preservative Requirements

The sample volumes, types, and preservative requirements are identified in **Table 5-8**.

Table 5-8. Sample Volumes, Types, and Preservative Requirements for Groundwater, Surface Water, and Sediment Samples
Jefferson Proving Ground, Indiana

Sample Type	Analysis	Volume	Container	Preservative
Surface Water	Total dissolved uranium	100 ml	Polypropylene bottle	4°C
Sediment	Total uranium or Thorium 234	1 L	Glass jar, can, or plastic bag	NA
Groundwater	Total dissolved uranium	100 ml	Polypropylene bottle	4°C

ml = milliliter
L = liter
°C = degrees Celsius
NA = not applicable

5.2.3 Quality Control Samples

In accordance with the QAPP (Appendix B), quality control (QC) samples will be collected to achieve data quality objectives. These samples include matrix spike/matrix spike duplicate (MS/MSD), field duplicate, and field replicate samples.

MS/MSD samples will be collected to evaluate the accuracy and precision of the analysis and the matrix effect of the sample on the analytical methodology. A pair of MS/MSD samples will be collected for every 20 samples of similar matrix received at the laboratory (10 percent). MS/MSD samples do not release the laboratory from its own QC requirements for laboratory control samples (LCSs).

A field duplicate sample is a second sample collected at the same location as the original sample. Duplicate samples are collected simultaneously or in immediate succession, using identical recovery techniques, and are treated in an identical manner during storage, transportation, and analysis. The sample containers are assigned an identification number in the field so that they cannot be identified (blind duplicate) as duplicate samples by laboratory personnel performing the analysis. Specific locations are designated for collection of field duplicate samples prior to the beginning of sample collection. Field duplicates will be collected at a ratio of 1 per 10 investigative samples collected.

A field replicate sample, also called a split, is a single sample divided into two equal parts for analysis. The sample containers are assigned an identification number in the field so that they cannot be identified as replicate samples by laboratory personnel performing the analysis. Specific locations are designated for collection of field replicate samples prior to the beginning of sample collection. Replicate sample results are used to assess precision.

5.2.4 Sample Identification

All sample containers will have the following information listed on the label:

- Unique sample identification
- Date and time of sample collection
- Source of sample (including name, location, and sample type)
- Designation of MS/MSD
- Preservative used
- Analyses required
- Name of collector(s).

5.2.5 Sample Custody

Procedures to ensure the custody and integrity of the samples begin at the time of sampling and continue through transport, sample receipt, preparation, analysis and storage, data generation and reporting, and sample disposal. Records concerning the custody and condition of the samples are maintained in field and laboratory records.

SAIC will maintain COC records for all field and field QC samples (**Table 5-7**). A sample is defined as being under a person's custody if any of the following conditions exist: (1) it is in his/her possession, (2) it is in his/her view, after being in his/her possession, (3) it was in his/her possession and he/she locked it up, or (4) it is in a designated secure area.

All sample containers will be sealed in a manner that will prevent or allow for detection of tampering if it occurs. Furthermore, each sample will be uniquely identified, labeled, and documented in the field at the time of collection.

Samples collected in the field will be transported to the laboratory as expeditiously as possible. When a 4°C requirement for preserving the sample is indicated, the samples will be packed in ice or chemical refrigerant to maintain the temperature of the samples at 4°C ± 2°C during collection and transportation. (During transit, it is not always possible to control the temperature of the samples rigorously. As a general rule, storage at low temperature is the best way to preserve most samples.) A temperature blank will be included in every cooler and used to determine the internal temperature of the cooler upon receipt of the cooler at the laboratory. If the temperature of the samples upon receipt exceeds the temperature requirements, the exceedance will be documented in laboratory records and discussed with SAIC's Project Chemist. Decisions regarding the potentially affected samples also will be documented.

After samples reach the laboratory, they will be checked against information reported on the COC forms for anomalies. The condition, temperature, and appropriate preservation of the samples will be checked and documented on the COC form. The occurrence of any anomalies in the received samples and decisions regarding the potentially affected samples will be documented in laboratory records.

The laboratory will confirm sample receipt and login information through the transmission of a letter of receipt (LOR) to the Project Chemist. Within 24 hours of sample receipt, the laboratory shall send a facsimile or e-mail a copy of the completed COC form, related login information, and a report specifying the condition of the samples upon receipt.

5.3 FIELD MEASUREMENTS

Procedures associated with field measurements are described in this section. Related equipment operation and maintenance procedures are identified.

5.3.1 Field Parameters

Request for instrumentation to support the sampling program, including field measurements, will be made no later than 30 days prior to the scheduled departure date. Radiation detection instrumentation, sampling tools, and pH, temperature, and conductivity instruments either will be rented or obtained from SAIC's equipment and supply center. Specific field measurements for groundwater, surface water, and radiation doses are described in the following paragraphs.

5.3.1.1 Groundwater

When collecting the groundwater sample, the field parameters of pH, temperature, conductivity, and turbidity will be monitored and recorded during purging of groundwater wells using a Horiba U-10 Water Quality Meter. Well purging will be complete after the indicator parameters have stabilized within the following ranges over three consecutive readings:

- pH = 0.2 pH units
- Temperature = 1°C
- Conductivity = 10 percent.

Measurements of static water level will be taken prior to purging and sampling and upon completion of sampling using an electronic water level indicator. The groundwater level will be

measured to the nearest 0.0l ft and from a marked survey datum on the rim of the riser. The water level measurements will be recorded on the monitor well static water level form. Wells that are dry will be noted as such. Groundwater levels will be measured in all wells to be sampled in as short a period as practical. The electronic water level indicator will be decontaminated between each monitoring well measurement.

5.3.1.2 Surface Water

After collecting the surface water sample, the pH, temperature, and conductivity will be collected at the sample location with the Horiba U-10 Water Quality Meter and recorded in the Surface Water Sample Collection Worksheet (**Table 5-4**).

5.3.1.3 Gamma Radiation Measurements

Radiation exposure rate measurements will be taken at 1 m above the sample location and recorded on the respective data collection worksheet (**Tables 5-2, 5-4,** or **5-6**).

Measurements will be performed with a portable radiation survey instrument that is sensitive to gamma radiation. The instrument should be held 1 m above the sampling location. The radiation levels will be documented on the appropriate form (**Table 5-2, 5-4,** or **5-6**). Any comments and notations that may be necessary for interpretation of the results should be recorded on the form.

5.3.2 Equipment Calibration and Quality Control

Upon receipt of instruments, appropriate instrument QC checks will be conducted to ensure proper operation prior to departure.

Radiation detection instrumentation will be checked for response against a radiation check source. This check source also should be shipped to the survey site for instrument verification onsite. The radiation check source used need not be a calibrated source because instrument response is the parameter being evaluated. The check will be performed daily or as needed to ensure accurate and precise readings.

Water quality instruments also should be verified using the manufacturer's procedures. These instruments will be calibrated daily per the manufacturer's guidelines. More frequent calibration may be necessary if field personnel suspect that the initial calibration may have been affected by external factors (e.g., temperature or humidity). Field measurements to be performed include water level measurement, pH, conductivity, temperature, and turbidity. All equipment to be used during the field sampling will be examined to certify that it is in operating condition. This examination will include checking the manufacturer's operating manual and instructions for each instrument to ensure that all maintenance requirements are being observed.

Calibrations will be recorded on the Measuring and Testing Equipment forms in accordance with SAIC Quality Assurance Administration Procedure (QAAP) 12.1, *Control of Measuring and Test Equipment.* In the event that an internally calibrated field instrument fails to meet calibration/checkout procedures, a HOLD tag will be attached, the instrument will be returned to the supplier or manufacturer, and a backup instrument will be used in its place. Project personnel responsible for calibrating and operating field instruments will receive training

in the proper use of each instrument. The satisfactory operating condition of equipment and instrumentation used onsite will be verified before each piece of equipment is shipped to JPG.

5.3.3 Equipment Maintenance and Decontamination

Decontamination operations will be conducted to reduce the potential for cross-contamination from sampling equipment that will be reused. Bailers, twine, nitrile gloves, and other such disposable items will not be reused but will be disposed of properly according to SAIC protocol. All reusable field equipment will be decontaminated by using potable or DI water (transported to each sampling location) before sampling activities begin, between sampling activities, and after sampling activities are completed at each site. The use of DI water will be required in the decontamination process of sampling equipment that comes into direct contact with analytical samples.

Equipment decontamination for sampling activities will include rinsing the following equipment with DI water after sampling and measurements are completed at each sample location:

- Electronic water level indicators
- Probe for the water quality meter (Horiba Model U-10).

The scoops or trowels used for soil sampling will need to be decontaminated in the following manner:

- Potable water rinse
- Scrubbed in an alconox and potable water bath
- Potable water rinse
- DI water rinse.

All rinse water will be collected in a purge water collection vessel for proper disposal. In addition, field personnel will prevent the equipment from coming into contact with potentially contaminating substances, such as tape, oil, engine exhaust, corroded surfaces, and dirt by wrapping tools or equipment with aluminum foil when necessary.

Decontamination operations will be conducted to reduce the potential for cross-contamination from sampling equipment and machinery.

5.4 WASTE MANAGEMENT

Waste management (e.g., purged groundwater, equipment decontamination liquids, and disposable personal protective clothing) will be addressed on a site-by-site basis. Waste may be classified as non-investigative waste or investigation-derived waste (IDW).

Non-investigative waste, such as litter and household garbage, will be collected on an as-needed basis at each sample location in a clean and orderly manner. This waste will be containerized and transported to a JPG-designated collection bin. Acceptable containers will be sealed boxes or plastic garbage bags.

IDW will be containerized and temporarily stored at each site prior to transport to a JPG-designated storage location. Depending on the constituents of concern, fencing or other special marking may be required. Acceptable containers will be sealed, U.S. Department of Transportation (DOT)-approved steel 55-gallon drums or small dumping bins with lids. The containers will be transported to prevent spillage or particulate loss to the atmosphere.

Each container will be labeled properly with site identification, sampling point, depth, matrix, constituents of concern, and other pertinent information for waste management.

IDW generated during groundwater sampling includes purged groundwater, equipment decontamination liquids, and disposable personal protective clothing. Purged groundwater and equipment decontamination liquids will be containerized in 55-gallon drums. Mixing of the fluids is permissible. The drums will be labeled and transported to a secure staging area designated by JPG. In no instance will a drum containing IDW be left unattended at an unsecured location. The drums will be staged on pallets (with built-in secondary containment) and covered with plastic sheeting. Disposable personal protective equipment (PPE) will be placed in plastic bags and disposed of in a site dumpster. PPE will be scanned for radiological contamination prior to disposal.

After field activities are completed, a representative sample of the wastewater will be collected for analysis. The sample will be a composite composed of liquid from each drum of liquid IDW. Based on the results of the analysis, an appropriate disposal option will be selected. If the water meets the discharge limits, it will be released to the ground surface. If water analyses indicate that levels exceed discharge limits, the water will be transported and disposed of offsite.

5.5 RECORDKEEPING

Field records will be maintained to a sufficient level of detail to re-create all sampling and measurement activities. The requirements listed in this section apply to all measuring and sampling activities. Requirements specific to individual activities are listed in the section that addresses each activity. The information will be recorded with indelible ink in a permanently bound notebook with sequentially numbered pages. These records will be archived in an easily accessible form and made available to the U.S. Army upon request.

The following information will be recorded for all field activities: (1) location, (2) date and time, (3) identity of people performing the activity, and (4) weather conditions. The following information will be recorded for field measurements: (1) the numerical value and units of each measurement and (2) the identity of and calibration results for each field instrument.

The following additional information will be recorded for all sampling activities: (1) sample type and sampling method, (2) the identity of each sample and depth(s), where applicable, from which it was collected, (3) the amount of each sample, (4) sample description (e.g., color, odor, clarity), (5) identification of sampling devices, and (6) identification of conditions that might affect the representativeness of a sample (e.g., refueling operations, damaged casing).

Sampling and field measurements will be recorded on the forms listed in this section (**Tables 5-2, 5-4, 5-6,** and **5-7**). Additional forms or the field log book will be used to record such information as water level and purge data.

The results of a sampling event completed in support of the ERM program will be documented and provided to SBCCOM. The report will include, but not necessarily be limited to, planned and actual sampling events, analytical and field results, data quality assessment results, and completed forms. A draft and a final report on the sampling event will be prepared.

6. SITE ACCESS CONTROLS

This section defines site access controls that will be in effect in accordance with the amendment to NRC License SUB-1435. These controls are intended to prevent and control access to the installation as well as the DU Impact Area. **Figure 6-1** shows the general location of areas with UXO, the DU Impact Area, and the active bombing areas. Because of the presence of UXO and DU and the occasional ANG bombing practices, access to and use of the area north of the firing line is limited. Agricultural, residential, or industrial activities are not permitted. To control access to and use of the area north of the firing line, the U.S. Army has used and will continue to use a variety of institutional controls. These institutional controls and the Army's permitting system and requirements for the FWS and USAF, organizations that manage all or portions of the installation north of the firing line, are addressed below.

The specific institutional controls[1] that have been and will be implemented by the Army include physical, legal, and administrative mechanisms, examples of which follow:

1. The U.S. Army will retain title to the JPG, north of the firing line.

   The U.S. Army will control access to and activities on the portion of the JPG north of the firing line. Access to the approximately 51,000 acres north of the firing line is and will continue to be restricted by a fence around the entire area. Warning signs are and will continue to be posted along the fence line. No demolition, excavation, digging, drilling, or other disturbance of the soil, ground, or groundwater, or use of soil, ground, or groundwater for any purpose will be permitted without written approval of the Army. Public access will be allowed only in selected areas that do not have UXO or DU. These areas primarily are along the inside of the perimeter fence and on the northern portion of the JPG, as shown in **Figure 6-1**. When public access is allowed, the visitors will receive a safety briefing on the hazards and will be required to sign a statement acknowledging the hazard and agreeing to hold the Army harmless.

2. In 1995, the U.S. Army retroceded exclusive jurisdiction over JPG to the State of Indiana (U.S. Army 1995b). Under the Interim Public Access Plan for the Big Oaks National Wildlife Refuge (NWR), the FWS, in consultation with the USAF, developed and coordinated law enforcement strategies to enforce refuge trespasses and other public use violations (U.S. Army 2000b and c).

[1] The U.S. Department of Defense's definition of land use controls includes physical, legal, and administrative mechanisms to control access to and/or use of real property. Institutional controls are legal controls under the National Contingency Plan; however, in the context of this ERM program, institutional controls and land use controls are synonymous. At JPG, all three types of land use controls are and will be in effect.

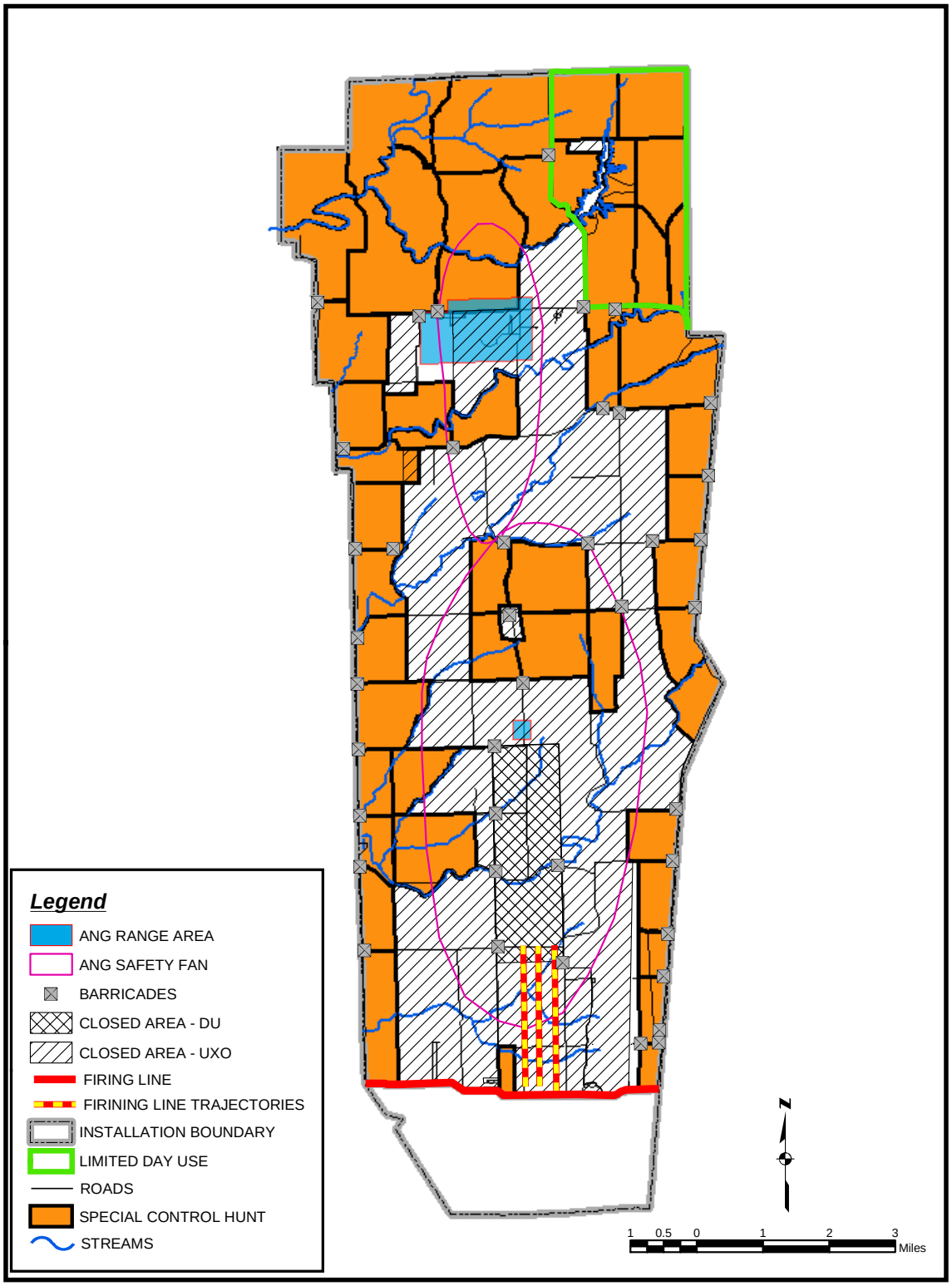

Figure 6-1. Potential Public Uses at the Big Oaks National Wildlife Refuge Jefferson Proving Ground, Indiana

3. Additional access controls are applied to the DU Impact Area, including locked barricades on access roads and signs around the perimeter stating, "No Trespassing" and "Caution – Radioactive Material." Key access for the barricades is limited to personnel formally authorized by the U.S. Army. Quarterly lock and key inventories are conducted. Access to the DU Impact Area is limited to individuals conducting official U.S. Government business.

4. The Army may authorize permits for other U.S. Government agencies to use the land, but such permits will require compliance with all the controls listed above and maintenance requirements listed in this section of the plan. At present, the Army has an agreement with the FWS for management of the Big Oaks NWR and with the USAF for use of portions of the JPG as a bombing range (U.S. Army 2000b and c). The Army will conduct inspections to ensure compliance with the terms of the permit, as appropriate. If violations of the permit conditions are identified, the Army retains the right to suspend the site activities of the other Government agency until appropriate corrective action is taken. The Army will conduct a formal review of the effectiveness of any permits and the effectiveness of the land use controls every 5 years.

5. Records of visitors to the area north of the firing line will be prepared and maintained by the Federal authority (the U.S. Army or a U.S. Army-permitted Federal authority) granting access to the area. The Army also will maintain a record of its review of the effectiveness of the institutional controls.

6. The Army, or its permitted Federal agencies, will patrol and inspect the perimeter fence weekly. The inspections will be documented to show the inspection date, the inspector, and the location of any fence damage. The Army, or its permitted Federal agencies, will repair any damage to the perimeter fence; maintain all roads, road shoulders, low water crossings, bridges, and culverts and provide access control signs at specified locations; and maintain the barricading and marking of all roads surrounding the DU Impact Area with radiation warning signs.

These institutional controls are planned to remain in place for the foreseeable future because of the presence of, and hazards associated with, both UXO and DU.

This page intentionally left blank.

7. 5-YEAR REVIEWS

As a condition of the NRC License SUB-1435, 5-year reviews will be conducted on the ERM program. The objective of this review is to assess the current ERM program and formulate the revisions to the program, as necessary and appropriate, if the Army were to request a license renewal.

Among the criteria to be used to determine if a license renewal is appropriate are the following:

- ***ERM Program Criteria*** – Factors may include, but not necessarily be limited to, the status of the ERM program, the results of media monitoring and associated trends, and difficulties or successes in radiation monitoring.

- ***Programmatic Criteria*** – Factors may include, but not necessarily be limited to, the organizational status of the licensee and related Army and NRC policies and regulations.

- ***Technology Criteria*** – Factors may include, but not necessarily be limited to, the status of radiation monitoring techniques and UXO detection and removal technology.

This page intentionally left blank.

8. REFERENCES

Abbott, D. Review of Environmental Monitoring Data at U.S. Army JPG, Madison, Indiana. Prepared by EG&G Mound Applied Technology, Ohio. July.

CHPPM (Center for Health Promotion and Preventative Medicine). 2003. Training Range Site Characterization and Risk Screening. Regional Range Study, JPG, Madison, Indiana. Draft. .

Davis. 1990. Environmental Assessment for Testing Uranium Penetrator Munitions at U.S. Army Combat Systems Test Activity, Aberdeen Proving Ground, Maryland.

Ebinger, M. H., and Hansen, W. R. 1996a. *Jefferson Proving Ground Data Summary and Risk Assessment*, LU-UR-96-835, Los Alamos National Laboratory, Los Alamos, New Mexico. LA-UR-96-3852. November.

Ebinger, M., and Hansen, W. 1996b. *JPG Data Summary and Risk Assessment*. Submitted to U.S. Army Test and Evaluation Command by Los Alamos National Laboratory New Mexico. LA-UR-96-835. February.

EPA (U.S. Environmental Protection Agency). 2000. Data Quality Objectives Process for Hazardous Waste Site Investigations. EPA/600/R-00/007. Office of Environmental Information. January.

FWS (U.S. Fish and Wildlife Service). 2001. Fire Management Plan. Big Oaks National Wildlife Refuge, Madison, Indiana. March.

Johansen, M. P., Hakonson, T. E., Whicker, F. W., Simmanton, J. R., and Stone, J. L. 2001. "Hydrologic response and radionuclide transport following fire at semiarid sites." *Journal of Environmental Quality* **30**:2010–2017.

Kerekes, A., Capote-Cuellar, A., and Koteles, G. J. 2001. "Did NATO attacks in Yugoslavia cause a detectable environmental effect in Hungary?" *Health Physics* **80**:177–178.

Kraig, D.H., T.E. Eberhart, C.F., and Gladney, E.S. 2001a. Updated Calculation of the Inhalation Dose from the Cerro Grande Fire Based on Final Air Data. Los Alamos National Laboratory Report LU-UR-01-1132, Los Alamos, New Mexico.

Kraig, D. H., Buhl, T. E., Eberhart, C. F., and Gladney, E. S. 2001b. *Updated Calculation of the Inhalation Dose from the Cerro Grande Fire Based on Final Air Data*. Los Alamos National Laboratory Report, LU-UR-01-1132, Los Alamos, New Mexico.

NRC (Nuclear Regulatory Commission). 1989. Materials License SUB-1435. Amendment 5. Application dated May 3, 1989. Expiration data of September 30, 1994. August 16.

NRC 1996. Materials License SUB-1435, Amendment No. 9. May 8.

NRC. 2003. Policy Issue Information from William Travers, NRC, Executive Director for Operations to the Commissioners Regarding JPG Decommissioning Status. SECY-03-0031. March 3.

Royal Society. 2002a. "The Health Effects of Depleted Uranium Munitions, Part I." Available at www.royalsoc.ac.uk (5/5/2002), Document 6/02, March 2002.

Royal Society. 2002b. "The Health Effects of Depleted Uranium Munitions, Part II." Available at www.royalsoc.ac.uk (5/5/2002), Document 6/02, March 2002.

Rust. 1998. JPG South of the Firing Line, Phase II Draft Remedial Investigations. Prepared for USAEC, Aberdeen Proving Ground, Maryland. August.

SAIC (Science Applications International Corporation). 1997. Base Realignment and Closure Cleanup Plan. Version 3. Prepared for the USAEC under Contract DACA31-94-D-0066, DO 0001. June.

SEC Donahue, Inc. 1992. *Letter Report of Site Specific Sampling and Analysis Program Results*. Prepared for U.S. Army Toxic and Hazardous Materials Agency. August.

SEG (Scientific Ecology Group). 1995a. *Technical Basis Document, Use of the In Situ Gamma Spectroscopy System to Determine Soil Activity Concentrations.* July.

SEG. 1995b. *JPG Depleted Uranium Impact Area, Scoping Survey Report. Volumes 1–3*. March.

SEG. 1996. *Jefferson Proving Ground Depleted Uranium Impact Area Characterization Survey Report. Volume 1*. Oak Ridge, Tennessee. February.

U.S. Army. 1988. Environmental Assessment for Renewal of NRC License for Testing Depleted Uranium at JPG. Prepared by U.S. Army, JPG. July 19.

U.S. Army. 1991. *Final Environmental Impact Statement: Closure of Jefferson Proving Ground Indiana and Realignment to Yuma Proving Ground Arizona*, U.S. Army, Alexandria, Virginia. September.

U.S. Army. 1995b. Letter from Deputy Assistant Secretary of the Army to the Governor of the State of Indiana Regarding Retrocession. April 4.

U.S. Army. 1986. Request to Amend NRC License SUB-1436 and SUB-1299. Amendment 1. April 10.

U.S. Army. 2000a. "Standard Operating Procedure (SOP). Depleted Uranium Sampling Program, Environmental Radiation Monitoring Program, JPG, Indiana." SOP No. OHP 40-2. March 10.

U.S. Army. 2000b. Department of Army Permit to Fish and Wildlife Service to Use Property Located on JPG, Madison, IN. June 27.

U.S. Army. 2000c. Department of Army Permit to Department of Air Force to Use Property Located on JPG, Madison, IN. November 30.

U.S. Army. 2002a. Decommissioning Plan for License SUB-1435. Jefferson Proving Ground, Madison, Indiana. Prepared by the U.S. Army SBCCOM by SAIC. June.

U.S. Army. 2002b. Environmental Report. Jefferson Proving Ground, Madison, Indiana. Prepared by the U.S. Army SBCCOM by SAIC. June.

U.S. Army. 2003. Letter to Mr. Larry Camper, Chief, Decommissioning Branch, NRC from Dr. John Ferriter, Director, Stockpile, Industrial, Remediation and Restoration, U.S. Army, Regarding Contingent Request for Alternative Schedule for Submittal of a Decommissioning Plan for the Termination of NRC License SUB-1435. February 4.

Williams, G. P., Hermes, A. M., Policastro, A. J., Hartmann, H. M., and Tomasko, D. 1998. *Potential Health Impacts from Range Fires at Aberdeen Proving Ground*. Report ANL/EAD/TM-79, Argonne National Laboratory, Argonne, Illinois.

This page intentionally left blank.

APPENDIX A

HISTORICAL DATA ASSESSMENT

TABLE OF CONTENTS

A. HISTORICAL DATA ASSESSMENT A-1

A.1 INTRODUCTION A-1

A.2 BACKGROUND A-1

A.3 ANALYSIS METHODOLOGY A-2

A.4 DATA ANALYSIS A-2
A.4.1 Groundwater A-3
A.4.2 Surface Water and Sediments A-3
A.4.3 Soils A-4

A.5 OPTIMIZATION AND RISK MANAGEMENT OF GROUNDWATER MONITORING SYSTEMS IN KARST ENVIRONMENTS A-4
A.5.1 Long Term Monitoring Network Design A-4
A.5.2 Risk Mitigation A-5

A.6 RECOMMENDATIONS A-6

A.7 REFERENCES A-7

This page intentionally left blank.

LIST OF ACRONYMS AND ABBREVIATIONS

ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
DMSO	Defense Modeling and Simulation Office
DOE	U.S. Department of Energy
DU	depleted uranium
EPA	U.S. Environmental Protection Agency
ERM	Environmental Radiation Monitoring
JPG	Jefferson Proving Ground
pCi/g	picocuries per gram
pCi/L	picocuries per liter
QA/QC	quality assurance/quality control
UXO	unexploded ordnance

This page intentionally left blank.

A. HISTORICAL DATA ASSESSMENT

In support of development of the sampling strategy and plans for Jefferson Proving Ground's (JPG's) environmental radiation monitoring (ERM) program, historical data from the ERM program were reviewed and discussed in the context of the groundwater monitoring system. The results of this assessment are provided in this appendix.

A.1 INTRODUCTION

The objectives of this review and analysis of JPG ERM data were two-fold:

1. To review the existing information and assess its content with respect to making informed decisions about site conditions

2. To propose a sampling plan the next 5 years.

A.2 BACKGROUND

The site conditions are addressed in Section 2 of this ERM Program Plan and in source documentation. The relevant information about the site is provided here:

1. The site's intended use resulted in disposal of residual uranium and other chemicals in the environment. This information is presented in the ERM Program Plan and includes references to source documentation.

2. Samples of uranium have been collected in various environmental media since 1984. The sampling program consists of periodic sampling of groundwater, surface water, sediments, and soils.

3. The nature of site operations has resulted in hazards through the deposition of unexploded ordnance (UXO). There is no proven method of clearly identifying UXO in the subsurface, although much promising research is being conducted on UXO/MineFinder (Deschaine et al. 2002), and other instruments as reported in the Annual U.S. (UXO Forums) and European (EUDEM2-SCOT) conferences. There is a potential risk of UXO float due to freeze/thaw cycles that reduce the certainty of current uncleared areas or areas previously cleared as being safe. Therefore, advancements in the state-of-the-art in UXO detection and removal technologies are necessary to ensure that designated areas are safely, completely, and cost effectively cleared prior to conducting sampling programs.

4. The site is located in karst topography; therefore, the complex physics of flow and transport in fractured media apply. In these systems, the flow patterns may or may not match the directions typically inferred from the slopes indicated on groundwater table maps. Therefore, locating monitoring wells directly downgradient of a source area is complicated. In addition, migration of uranium in the subsurface is a complex biogeochemical reactive process. These issues are discussed in the U.S. Environmental Protection Agency (EPA) report "Understanding Variation in Partition Coefficient, K_d, Values" (EPA 1999). Volume I discusses the general physics of multi-component transport, and volume II has a section specifically devoted to uranium.

The speciation and effective "K_d" is highly dependent on the subsurface hydrogeochemistry. Data collection for these types of analyses (fractured flow with multi-component geochemical transport) is intensive and essentially is precluded at JPG because of the current safety issues associated with the presence of UXO in the Depleted Uranium (DU) Impact Area.

A.3 ANALYSIS METHODOLOGY

An initial screening model was developed and assessed for DU transport for the Aberdeen and Yuma Proving Grounds (Ebinger et al. 1990). The report acknowledges the need for using multi-component, geochemical transport techniques rather than the lumped parameter K_d retardation approach. The K_d retardation approach has severely limited predictive value (Nikolaidis et al. 1999). Therefore, the application of a comprehensive numerical model is not possible at this time because of the need for site-specific data to enhance its predictive capability. As noted above, data to support this model are not available and cannot be obtained because of the presence of UXO at the site.

Fortunately, data have been collected at the DU Impact Area in support of the ERM program since 1984; therefore, trend analyses can be completed. The question is whether or not the sample trends provide adequate information to make decisions on the optimal sampling strategy for this site. On the basis of analyses completed for this ERM Program Plan, the sample trends provide sufficient information to make informed decisions on future monitoring of this site.

Optimal sampling design, discussed in *The Data Quality Objectives Decision Error Feasibility Trials (DEFT) Software* (EPA 1994), calls for designers of sampling programs to "formulate the mathematical expressions needed to solve the design problem for each data collection design alternative." Currently, more than 20 methods are available to decisionmakers (EPA 2000). Some of these methods are incorporated in spreadsheets (U.S. Department of Energy [DOE] 2002), and other advanced methods include the integration of flow and transport modeling with field data using Kalman filtering and optimal long-term sampling policy design using evolutionary algorithms (Deschaine 2003).

These methodologies support the development of a sampling program that optimizes the number, location, and frequency of samples consistent with data quality objectives. A subset of these strategies was used to perform a top-level analysis of the JPG data set supporting the ERM program. Because the physical model is not available, the analyses focused on the information available from the sampling events over time.

A.4 DATA ANALYSIS

In support of the analysis, the following activities were completed: data compilation, top-level quality assurance/quality control (QA/QC) review, and statistical analyses, including identification of trends if appropriate. This assessment was limited to groundwater, surface water, sediment, and soil media. Additional supporting information for recommendations provided herein is in Section 3 of this report. Air and biotic media are addressed separately (Section 3) and based on a historical data review.

A.4.1 Groundwater

The trends of 274 samples collected from 11 of the monitoring wells during the period 1984 through 2002 were developed and assessed. The average total uranium concentration was 2.35 picocuries per liter (pCi/L); the standard deviation was 3.64. All wells located within the DU Impact Area exhibited a downward trend. Only MW-3 and MW-4, located outside the DU Impact Area, exhibited slight upward trends (see **Figure 2-1** in Section 2 of this report).

Further analysis of the total uranium concentration trends for the groundwater monitoring data is not needed to assess the adequacy of the program. The ERM program is providing more information than is needed to make informed decisions about the potential risks to onsite and offsite human and ecological receptors. The more recent data involved uranium concentrations much lower than the action levels, and the trends in the DU Impact Area and most other areas are downward. Location MW-3 (near the firing line) is essentially flat. MW-4 is in the southeastern corner of the facility, away from the major DU activities. The concentrations detected in this well are very low level, so the "trend" may be suspect.

An assessment of the sampling frequency was conducted using data for one well. The purpose of this analysis was to determine the impact of results on decisions if fewer data were available. MW-4 was selected as the test case because it evinced the strongest upward trend, which was still well below the recommended action level. The linear extrapolation of the expected total uranium concentration in 2007 would be approximately 2 pCi/L, a value well below the action level of 20 pCi/L. This well was sampled 25 times in 18 years. Randomly removing one-half of the samples (leaving 12 for the analysis) and one-third of the samples (leaving 8 for the analysis) from the initial complete data set resulted in an upward trend with similar projected concentrations in 5 years. Even at the random but average sample rate of one sample per 2-year interval over an 18-year period, no change in the predictive ability garnered from the sample information was found. Consequently, decisions would not have changed with a smaller sample set.

Recommendations include annual sampling of MW-3 and MW-4 and randomly selecting 50 percent of the remaining wells. MW-3 was selected because of its location and data trends (i.e., data from this well have a very slight upward trend). MW-4 was selected because of the slight upward trend in the data. The well is far removed from the activities, so the implications of this trend are uncertain at this time. As part of the annual sampling program, a trend analysis would be completed. A review of the site conditions in these areas during this annual sampling event also is recommended.

A.4.2 Surface Water and Sediments

The time scale and variation of surface water systems are different from groundwater. Whereas groundwater systems are very slow, surface water and sediment environments respond rapidly to rainfall events. As a result of these variable conditions, cause-effect relationships are difficult to establish. These factors impact the planning of an effective monitoring program.

Based on an assessment of 72 samples collected from nine locations since 1998, the following results were determined:

1. Total uranium concentrations in surface water samples were all below 3.38 pCi/L with the exception of SW-5, which had a one-time reading of 29 pCi/L in 1999.

2. All total uranium concentrations in sediments were at or below 3 pCi/L.

Comprehensive sampling of soil and sediment (as well as other media) was conducted during the Range Study (Center for Health Promotion and Preventative Medicine [CHPPM] 2003). Even with the extensive sampling completed, patterns neither were discernable nor were risks to potential receptors identified. It is unlikely that increasing the number of samples for these media would generate different results or change the conclusions regarding potential risks to ecological and human receptors.

An expanded sampling program is not warranted at this time given the fact that no discernable patterns are evident and concentrations of uranium are well below the action level. Recommendations include annual sampling of the exit points of the Big Creek and Middle Creek and 50 percent of the remaining seven monitoring points using a random lottery selection process. Consideration might be given to annual sampling of SW-5 and SES5 given the one-time high reading.

A.4.3 Soils

The soils sample data (1996 to present) from four locations (SOS1 to SOS4) were reviewed. SOS1 and SOS2 always were below 2 picocuries per gram (pCi/g), SOS3 always was below 5 pCi/g, and SOS4 had two readings in 1998 of 60 pCi/g and 140 pCi/g. The remaining data were all below 4 pCi/g.

Further sampling of soil at these locations is not recommended given the trends in other media (i.e., decreasing uranium concentrations in groundwater, low level of radiological contamination in surface water and sediment) and inherent sampling bias (i.e., sample locations were cleared of DU penetrators to support the ERM program, which renders the value of sampling data from these surface soil samples as questionable). Historical soil sampling data verify this statement. Furthermore, additional soil sampling at other locations within the DU Impact Area is not recommended because of the (1) UXO risks and additional costs associated with protection of field crews from UXO hazards and (2) evidence that soil has not been significantly impacted from firing range activities (CHPPM 2003). This decision will be revisited if there are significant changes in the status of DU contamination at the site as well as at the 5-year review (Section 7).

A.5 OPTIMIZATION AND RISK MANAGEMENT OF GROUNDWATER MONITORING SYSTEMS IN KARST ENVIRONMENTS

This section addresses two key topics related to optimizing groundwater monitoring systems, namely, design of the network (Section A.5.1) and risk management (Section A.5.2).

A.5.1 Long Term Monitoring Network Design

The design of effective and efficient groundwater monitoring well networks in either porous or fractured media is complex. Techniques used for developing effective and efficient long-term monitoring plans are documented in publications (e.g., Minsker 2003 and EPA 2000). Specifically germane to this site's subsurface condition is the work discussed on fractured flow systems in Bear, Tsang, and de Marsily 1993.

It is more complex to design a monitoring network for this site because the subsurface geology is fractured media and may exhibit characteristics of systems described by dual porosity/dual permeability physics. Collection of required site data is constrained because of the presence of UXO and uncertainty in its location.

To assess the groundwater conditions in and surrounding the DU Impact Area, a number of groundwater monitoring wells were installed and sampled over a substantial period at locations experts believed adequate for acquiring such information. The concentrations in all the wells are either stable or declining. Assessing the system as a whole, triggers were not identified that would indicate a plume that was increasing in concentration anywhere.

No one can ensure that groundwater monitoring systems in karst environments will not involve a contaminant "end-running" a network (i.e., this is an unachievable goal). With the current data set, however, statements can be made on whether or not uranium concentrations are stable or decreasing.

It is well known that a complete deterministic description of the preferential pathways is not possible in karst/fractured environments. Hence, stochastic representation of these fracture patterns, using either a porous media equivalent or a dual porosity/dual permeability approach, is one way to reduce the uncertainty in the flow system. Details about how to do this using a stochastic fractured media representation are discussed in Bear, Tsang, and de Marsily 1993. Despite the availability analyses and examples of this type of stochastic analysis for fractured systems, the American Society of Civil Engineers (ASCE) indicates that continued research on fractured media is necessary: "Geo-statistical methods that better incorporate linear and planer connectivity embedded in the three-dimensional subsurface are needed…"(Minsker 2003).

The use of currently available advanced long-term monitoring techniques at this site, those that link physical subsurface simulators with spatial-temporal field data using Kalman filters, would require the assumption of a porous media model, which would not be acceptable from the premise of this fractured media site. While tools needed for fractured media could be developed, the results would have to be validated given the research and development focus of the analysis.

Given these constraints, the Army is relying on the historic sampling data from existing wells to make informed decisions about the presence and potential migration of contamination from the site. The approach used to assess the information content of the data reflects the ability to make informed decisions while recognizing complexities posed by fractured systems.

A.5.2 Risk Mitigation

The Army and stakeholders are sensitive to this follow-on question: "What is the risk if something goes wrong and how would the situation be mitigated?" Mitigation of potential failures is discussed in the Defense Modeling and Simulation Office's (DMSO) guidance document entitled, "Risk Assessment and Its Impact on Validation." A "failure" can be defined as a conceptual or numerical model producing incorrect results that are believed to be correct when used for its intended purpose. The first step in risk mitigation is to define clearly the intended purpose of the site representation or model and its limitations.

The next step in risk mitigation is developed from a consensus ranking of the importance of failure categories on operational effectiveness. This ranking comprises two components: the impact (or consequences) and the probability of the occurrence. MIL-STD-882D provides guidance on criteria for determining impact levels. Impact categories for the long-term monitoring program can include such factors as personnel safety, equipment safety, environmental damage, occupational illness, cost, performance, schedule, and political or public impact. Impact levels may be described as catastrophic, critical, marginal, or negligible. The probability of occurrence may include the following categories: frequent, probable, occasional, remote, or improbable.

The stakeholder team defines these terms in the context of the long-term monitoring program. Assembly of these components into an overall decision matrix is accomplished and processed using the analytical hierarchy process or other decision support algorithm to produce a rank-ordered list of the potential risks and associated severity. This approach provides the stakeholder team with the knowledge and ability to mitigate the impacts of potential model failure to an acceptable level.

Any model of a system is an imperfect representation. The degree to which a model is needed to represent the real system, and its fidelity, are defined early in the evaluation process. The difficulty of developing a high fidelity numerical model for this site is acknowledged. During model development, the American Society for Testing and Materials (ASTM) and DMSO guidance is used to verify and validate that the model solves the right problem correctly. Model verification and validation reduces development risks to an acceptable level. This process entails concept or code testing, the use of subject matter experts, and peer review. An example of testing a conceptual or numerical model/representation is to show a subject matter expert output from the real system and the model, with the goal of differentiation between the two systems. If the subject matter expert can differentiate the one from another with a certain degree of statistical confidence, then the results are used to improve the model of the system.

In the case of the DU Impact Area, approximately 20 years of sampling data represent site conditions. Data indicate that the uranium contamination is well below the trigger levels defined in this ERM Program Plan. The question posed is whether the conceptualized site model that was used to locate the monitoring wells in the first place is correct. Because these wells are showing stable/declining concentrations of uranium significantly far below any action level, the conceptual site model used to define, test, and validate the DU Impact Area is hypothesized to be valid. Formal application of the DMSO guidance to the groundwater monitoring system for the DU Impact Area may be an appropriate next step. This process would be used to confirm this hypothesis, expand understanding of the site and the conceptual model, and evolve the monitoring system's capabilities.

A.6 RECOMMENDATIONS

The current groundwater monitoring system should be used to assess the status and trends of uranium contamination employing the action levels and procedures defined in the ERM Program Plan. In addition, a stakeholder group (e.g., Restoration Advisory Board), composed of the Army, regulatory community, and subject matter experts, should be formed and convened to review the results of the monitoring program annually and to assess the potential risks in the

context of the DMSO guidance. The group also could make recommendations on improving monitoring system effectiveness, either through field or analytical procedures.

A.7 REFERENCES

Bear, J., Tsang, C. F., and de Marsily, G.. 1993. Flow and Contaminant Transport in Fractured Rock. Academic Press, 560 pages.

CHPPM (Center for Health Promotion and Preventative Medicine) 2003. Training Range Site Characterization and Risk Screening. Regional Range Study, JPG, Madison, Indiana. Draft. April 30.

Department of Energy, 2002. Visual Sample Plan, Version 2.0 Users Guide and Software. Available from http://dqo.pnl.gov/vsp.

Deschaine, L. 2003. *Mathematical Simulation and Optimization of Subsurface Environmental Contamination Events*. Ph.D. Dissertation, In Press, Institute of Physics, Chalmers University of Technology and Göteborg University, Göteborg, Sweden.

Deschaine, L. M., Hoover, R. A., Skibinski, J. N., Patel, J. J., Francone, F. D., Nordin, P., and Ades, M. J. 2002. Using Machine Learning to Compliment and Extend the Accuracy of UXO Discrimination Beyond the Best Reported Results of the Jefferson Proving Ground Technology Demonstration. Society for Modeling and Simulation International's Advanced Technology Simulation Conference, San Diego, California. April.

Ebinger 1990. Long-Term Fate of Depleted Uranium at Aberdeen and Yuma Proving Grounds. Final Report. Phase I: Geochemical Transport and Modeling.

EPA (U.S. Environmental Protection Agency) 1994. *The Data Quality Objectives Decision Error Feasibility Trials (DEFT) Software* (EPA QA/G-4D). EPA/600/R-96/056. Office of Research and Development.

EPA 1999. Understanding Variation in Partition Coefficient, K_d, Values. EPA-402-R99-004A&B. August.

EPA 2000. Guidance for Data Quality Assessment (DQA), EPA QA/G9. EPA/600/R-96-084. Office of Environmental Information. July.

Minsker, B. 2003. Long-term Groundwater Monitoring – The State of the Art. ASCE Press 103 pp.

Nikolaidis, N. P., Deschaine, L. M., Shen, H., and Ades, M. J. 1999. Multi-Component Simulation of the Transport of Heavy Metals in Groundwater Systems. Presented at the Annual Society for Computer Simulation's Advanced Simulation Technology Conference, Waste Management and Environmental Sciences Section, April, Atlanta, Georgia. ISBN 1-56555-167-2, pp. 211–216.

This page intentionally left blank.

APPENDIX B

QUALITY ASSURANCE PROJECT PLAN

TABLE OF CONTENTS

B. QUALITY ASSURANCE PROJECT PLAN B-1

B.1 PROJECT DESCRIPTION B-1

B.2 PROJECT ORGANIZATION AND RESPONSIBILITIES B-1
- B.2.1 Project Manager B-1
- B.2.2 Field Manager B-2
- B.2.3 Quality Assurance/Quality Control Manager B-2
- B.2.4 Site Safety and Health Officer B-2

B.3 DATA QUALITY OBJECTIVES B-2
- B.3.1 Project Objectives B-3
- B.3.2 Quality Assurance Objectives for Measurement Data B-3

B.4 SAMPLING LOCATIONS AND PROCEDURES B-5
- B.4.1 Sample Containers, Preservation, and Holding Times B-6
- B.4.2 Field Documentation B-6
- B.4.3 Field Variance System B-7

B.5 SAMPLE CUSTODY AND HOLDING TIMES B-7
- B.5.1 Sample Documentation B-7
- B.5.2 Laboratory Chain of Custody Procedures B-8
- B.5.3 Final Evidence Files Custody Procedures B-9

B.6 ANALYTICAL PROCEDURES B-9
- B.6.1 Laboratory Analysis B-9
- B.6.2 Field Screening Analytical Protocols B-9

B.7 CALIBRATION PROCEDURES AND FREQUENCY B-10
- B.7.1 Field Instruments/Equipment B-10
- B.7.2 Laboratory Instruments B-10

B.8 INTERNAL QUALITY CONTROL CHECKS B-11
- B.8.1 Field Sample Collection B-11
- B.8.2 Field Measurement B-11
- B.8.3 Laboratory Analysis B-11

B.9 CALCULATION OF DATA QUALITY INDICATORS B-14
- B.9.1 Field Measurements Data B-14
- B.9.2 Laboratory Data B-15
- B.9.3 Project Completeness B-16
- B.9.4 Representativeness/Comparability B-16

B.10 CORRECTIVE ACTIONS B-17
- B.10.1 Sample Collection/Field Measurements B-17
- B.10.2 Laboratory Analyses B-18

B.11 DATA REDUCTION, VALIDATION, AND REPORTING B-20
- B.11.1 Data Reduction B-20
- B.11.2 Data Validation B-21

B.11.3 Data Reporting B-23
B.12 PREVENTIVE MAINTENANCE PROCEDURES B-23
B.13 PERFORMANCE AND SYSTEM AUDITS B-23
B.13.1 Field Audits B-24
B.13.2 Laboratory Audits B-24
B.14 QUALITY ASSURANCE REPORTS TO MANAGEMENT B-24
B.14.1 Quality Assurance Reports B-24
B.14.2 Quality Control Summary Reports B-25
B.15 REFERENCES B-26

LIST OF TABLES

B-1. Sample Data Quality Objective Summary B-5

LIST OF ACRONYMS

%R	percent recovery
COC	chain –of custody
DQO	data quality objective
DU	depleted uranium
EPA	U.S. Environmental Protection Agency
FCO	Field Change Order
FCR	Field Change Request
ERM	environmental radiation monitoring
JPG	Jefferson Proving Ground
LCS	laboratory control sample
LOR	letter –of receipt
MS/MSC	matrix spike/matrix spike duplicate
NCR	Non-Conformance Report
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
pH	hydrogen ion concentration
pCi/g	picocuries per gram
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QCSR	Quality Control Summary Report
RPD	relative percent difference
RPO	Radiation Protection Officer
SAIC	Science Applications International Corporation
SBCCOM	Soldier and Biological Chemical Command
SOP	standard operating procedure
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
USACE	United States Army Corps of Engineers

This page intentionally left blank.

B. QUALITY ASSURANCE PROJECT PLAN

B.1 PROJECT DESCRIPTION

This document presents the overall Quality Assurance Project Plan (QAPP) for activities to be performed during the Jefferson Proving Ground (JPG) Environmental Radiation Monitoring (ERM) program for the Depleted Uranium (DU) Impact Area. This effort is a part of the Nuclear Regulatory Commission (NRC) License SUB-1435 amendment. The United States Army and the United States Environmental Protection Agency (EPA) require that all environmental monitoring and measurement efforts mandated or supported by these organizations participate in a centrally managed quality assurance (QA) program. Any party generating data for this project has the responsibility to implement minimum procedures to ensure that the precision, accuracy, representativeness, completeness, and comparability of its data are known and documented. To ensure that these responsibilities are met uniformly, each party must adhere to the QAPP.

This QAPP presents the overall organization, objectives, functional activities, and QA and quality control (QC) activities associated with the JPG ERM program. It describes the specific protocols that will be followed for sampling, sample handling and storage, chain of custody (COC), and laboratory analysis. This plan also presents information regarding data quality objectives (DQOs) for the program, sampling and preservation procedures for samples collected in the field, field and sample documentation, sample packaging and shipping, and laboratory analytical procedures for all media sampled.

All QA/QC procedures are based on applicable professional technical standards, EPA requirements, Government regulations and guidelines, and specific project goals and requirements. This QAPP was prepared in accordance with EPA QAPP and United States Army Corps of Engineers (USACE) guidance documents, such as *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (EPA 1991), *Data Quality Objectives Process* (EPA 1993), *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations* (EPA 1994a), and *Requirements for the Preparation of Sampling and Analysis Plans* (USACE 2001). This document will be utilized in conjunction with the ERM Program Plan and Site Safety and Health Plan (SSHP).

B.2 PROJECT ORGANIZATION AND RESPONSIBILITIES

The overall organizational chart presented in the ERM Program Plan outlines the management structure that will be used to implement the site environmental monitoring efforts at the DU Impact Area. Functional responsibilities of key personnel implementing this QAPP are described in this section. The assignment of Science Applications International Corporation (SAIC) personnel to each position will be based on a combination of (1) experience in the type of work to be performed, (2) experience working with U.S. Army personnel and procedures, (3) a demonstrated commitment to high quality and timely job performance, and (4) staff availability.

B.2.1 Project Manager

The SAIC Project Manager manages the overall performance and quality of the ERM program for the U.S. Army Soldier and Biological Chemical Command (SBCCOM) under Contract No. F44650-99-D-0007, ECAS 189. This individual oversees the SAIC Field Manager in meeting project goals and objectives in a high-quality and timely manner. In coordination

with the Field Manager and the QA/QC Manager, this individual will address issues including identification of non-conformances and verification of corrective action.

B.2.2 Field Manager

The Field Manager has responsibility for assisting the Project Manager in meeting project goals and objectives in a high-quality and timely manner and coordinating project activities, including field activities, data management, and data reporting. This individual also will serve as a point of contact with the JPG Site Manager. The Field Manager will support the Project Manager in addressing non-conformance issues and verifying of corrective actions. The Field Manager is responsible for implementing all field activities in accordance with the ERM Program Plan and this QAPP. This individual is responsible for ensuring proper technical performance of field sampling activities, adherence to required sample custody and other related QA/QC field procedures, coordination of field personnel activities, checks of all field documentation, and preparation of Field Change Orders (FCOs) if required.

B.2.3 Quality Assurance/Quality Control Manager

The QA/QC Manager is responsible for project QA/QC in accordance with the requirements of the QAPP, other work plan documentation, and appropriate management guidance. This individual will be responsible for participating in the project field activity readiness review; approving variances during field activities before work continues; approving, evaluating, and documenting the disposition of Non-Conformance Reports (NCRs); and designing audit/surveillance plans followed by supervision of these activities.

The QA/QC Manager reviews analysis reporting performed by the subcontract laboratory/laboratories in accordance with the requirements defined in this QAPP. This individual coordinates the shipment of samples to the analytical laboratory. This individual will be responsible for resolving questions the laboratory may have regarding QAPP requirements and deliverables and coordinating data reduction, validation, and documentation activities related to sample data package deliverables received from the laboratories. The QA/QC Manager reports directly to the Project Manager.

B.2.4 Site Safety and Health Officer

The Site Safety and Health Officer (SSHO) is responsible for ensuring that health and safety procedures designed to protect personnel are maintained throughout the field activities. This will be accomplished by strict adherence to the applicable SSHP, which is prepared as a separate document (refer to Appendix C of the ERM Program Plan). This individual, in conjunction with the SBCCOM Radiation Protection Officer (RPO), will have the authority to halt field work if health or safety issues arise that are not immediately resolvable in accordance with the applicable SSHP. The SSHO reports directly to the Field Manager.

B.3 DATA QUALITY OBJECTIVES

The overall objective is to develop and implement procedures for field sampling, COC, laboratory analysis, and reporting that will provide information for site evaluation and assessment. Data must be technically sound and legally defensible. Procedures for sampling, COC, laboratory instrument calibration, laboratory analysis, reporting of data, internal QC, audits, preventive maintenance of field equipment, and corrective action are described in other sections of this QAPP. The purpose of this section is to address the objectives for data precision, accuracy,

representativeness, completeness, and comparability. The JPG ERM Program Plan identifies specific task objectives as they relate to site action levels. This QAPP provides the details of the analytical parameters, methods, and quantitation levels.

DQOs are qualitative and quantitative statements that specify the quality of data required to support decisions made during ERM activities and are based on the end uses for the data collected.

B.3.1 Project Objectives

General objectives are as follows:

- To provide data of sufficient quality and quantity to assess the nature and extent of potential contamination present in the media within the DU Impact Area of the JPG
- To ensure that samples are collected and analyzed using approved techniques and methods and are representative of existing site conditions
- To specify QA/QC procedures for both field and laboratory methodology to meet the U.S. Army and other applicable guidance document requirements.

B.3.2 Quality Assurance Objectives for Measurement Data

Laboratories are required to comply with all methods as documented. The laboratory selected for the project will be required to submit all project-relevant method standard operating procedures (SOPs) and references and the current associated method detection limit studies to the U.S. Army SBCCOM.

Definitive data represent data generated under laboratory conditions using EPA-approved procedures. Data of this type, both qualitative and quantitative, are used for determination of source, nature and extent, or characterization.

B.3.2.1 Level of Quality Control Effort

To assess whether QA objectives have been achieved, analyses of specific field and laboratory QC samples will be required. These QC samples include field duplicates, laboratory method blanks, laboratory control samples, laboratory duplicates, rinsate blanks, source water blanks, and matrix spike/matrix spike duplicate (MS/MSD) samples. Analytical criteria that are expected to apply to the ERM program are discussed in Section B.8.3 of this QAPP.

Field duplicates will be submitted for analysis to provide a means to assess the quality of the data resulting from the field sampling program. Field duplicates, which will be collected and analyzed at a frequency of 10 percent per sample matrix, are analyzed to determine sample homogeneity and sampling methodology reproducibility.

Rinsate and water source blanks will be submitted for analysis along with field duplicate samples to provide a means to assess the quality of the data resulting from the field sampling program. Rinsate blanks are used to assess the effectiveness of field decontamination processes in conjunction with water source blanks of the site potable water source used for decontamination. Rinsate and water source blanks will be collected and analyzed at a frequency of 10 percent, or a minimum of one sample per matrix sampled.

Field QA split samples will be collected as collocated or homogenized replicates of field samples and distributed to the designated SBCCOM QA laboratory for analysis. They will be implemented for detection of problems with field sampling, documentation, packaging, or shipping. They provide an independent laboratory analysis for checking the primary analytical results, sensitivity, accuracy, and precision. These QA split samples will be collected and analyzed at a frequency of 5 percent, or a minimum of one split sample per matrix sampled.

Laboratory method blanks and laboratory control samples are employed to determine the accuracy and precision of the analytical method implemented by the laboratory. Matrix spikes provide information about the effect of the sample matrix on the measurement methodology. Laboratory sample duplicates and MSDs assist in determining the analytical precision of the analysis for each batch of project samples. One MS/MSD sample will be designated in the field and collected for at least every 20 environmental samples.

The QC effort for in-field gamma radiation exposure rate measurements will include daily calibration of instruments using the National Institute of Standards and Technology (NIST) traceable standards and approved in-house SOPs. Daily calibration checks also will be performed on all radiation detection field meters. Field instruments and their method of calibration are discussed further in Section B.7 of this QAPP.

B.3.2.2 Accuracy, Precision, and Sensitivity of Analysis

The fundamental QA objectives for accuracy, precision, and sensitivity of laboratory analytical data are the QC acceptance criteria of the analytical protocols. An accuracy and precision summary for this project's analytical parameters is incorporated in **Table B-1** and will be consistent with the analytical protocols. Typical sensitivities (Reporting Limits) required for project analyses are provided in **Table B-1**.

Accuracy is the nearness of a result, or the mean of a set of results, to the true or accepted value. Analytical accuracy is expressed as the percent recovery of an analyte that has been added to a blank sample or environmental sample, at a known concentration, during sample preparation. Accuracy will be determined in the laboratory through the use of MS analyses, laboratory control sample (LCS) analyses, and blank spike analyses. The percent recoveries for specific target analytes will be calculated and used as a QC indication of the field procedures, matrix effects, and accuracy of the analyses performed.

Precision is the measure of the degree of reproducibility exhibited by a set of replicate results or the agreement among repeat observations made under the same conditions. Analytical precision will be determined through the use of spike analyses conducted on duplicate pairs of environmental samples (MS/MSD) or comparison of laboratory duplicate responses. The relative percent difference (RPD) between two positive results will be calculated and used as a QC indication of the field procedures, matrix effects, and precision of the analyses performed.

Sample collection precision will be measured in the laboratory by the analyses of field duplicates. Precision will be assessed during data validation and recorded as the RPD for two positive measurements of a given analyte.

Table B-1. Sample Data Quality Objective Summary

Sample Type	Precision Field Duplicates	RPD Lab Duplicates	Accuracy Laboratory (Matrix Spike)	Completeness Goals	Reporting Limits
Sediment	< 50 RPD	< 30 RPD	75–125% recovery	90%	2 pCi/g
Surface water/ groundwater	< 50 RPD	< 30 RPD	75–125% recovery	90%	1 pCi/L

pCi/g = Picocuries per gram
pCi/L = Picocuries/liter
RPD = Relative percent difference

B.3.2.3 Completeness, Representativeness, and Comparability

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount of data expected under normal conditions. The laboratory is required to provide data meeting system QC acceptance criteria for all samples tested. Overall project completeness goals take into account the potential for sample losses (e.g., breakage) and data losses (e.g., severe matrix interferences). Completeness goals are identified in **Table B-1**.

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

Representativeness is a qualitative parameter that depends upon the proper design of the sampling program and proper laboratory protocol. The sampling approach was designed to provide data representative of site conditions. During development of this plan, consideration was given to site history, past waste disposal practices, existing analytical data, physical setting and processes, and constraints inherent to this investigation. The rationale of the sampling design is discussed in detail in the ERM Program Plan.

Representativeness will be achieved by ensuring that the ERM Program Plan is followed. The DQO for representativeness is met when proper sampling techniques are used, appropriate analytical procedures are selected and followed, and holding times are not exceeded. Representativeness will be determined by assessing the combined aspects of the QA program, QC measures, and data evaluations.

Comparability expresses the confidence with which one data set can be compared with another. The extent to which existing and planned analytical data will be comparable depends upon the similarity of sampling and analytical methods. The procedures used to obtain the planned analytical data are expected to provide comparable data.

B.4 SAMPLING LOCATIONS AND PROCEDURES

Planned environmental sampling at the DU Impact Area includes surface water, groundwater, and sediment. Estimated numbers of samples by media and parameter are defined in the ERM Program Plan. Environmental samples will require radionuclide analyses. Field parameters, hydrogen ion concentration (pH), temperature, conductivity, and turbidity (groundwater only) will be measured for water samples.

The ERM Program Plan presents the rationale for the planned sampling program; the number, type, and locations of samples; and sampling procedures. In addition, this plan identifies the field equipment and supporting materials to be used for these investigations. Several different types of field measurements will be performed during the environmental sampling. A description of the field instruments and associated calibration requirements and performance checks to be used for field measurements is presented in the ERM Program Plan and Section B.7 of this QAPP.

B.4.1 Sample Containers, Preservation, and Holding Times

Sample containers, chemical preservation techniques, and holding times for sediments collected during investigations are described in the ERM Program Plan. The specific number of containers required for each study will be estimated and supplied by SAIC or the laboratory. Additional sample volumes will be collected and provided, when necessary, for the express purpose of performing associated laboratory QC (laboratory duplicates, MS/MSDs). Additional sample volumes generally apply to collecting water samples.

In the event that sample integrity, such as holding times, is compromised, resampling will occur as directed by the QA/QC Manager. Any affected data will be flagged and qualified per data validation instructions and guidance.

B.4.2 Field Documentation

Field documentation procedures, including protocol for sample numbering, are defined in this section.

B.4.2.1 Field Logbooks

Sufficient information will be recorded in the field logbooks to permit reconstruction of all drilling and sampling activities conducted. Information recorded on other project documents will not be repeated in the logbooks except in summary form where determined necessary. All field logbooks will be sequentially numbered and kept in the possession of field personnel responsible for completing the logbooks or in a secure place when not being used during field work. Upon completion of the field activities, all logbooks will become part of the final project file.

B.4.2.2 Sample Numbering System

A unique sample numbering scheme will be used to identify each sample collected, following the general outline established in the ERM Program Plan. The sample numbering system will use letter codes to distinguish matrices and various QC samples. Unique serial number ranges will distinguish sample type categories (e.g., regular field samples versus field duplicates). Also, location numbers in the form of sample location identification will be documented on the COC for each sample taken. The purpose of this numbering scheme is to provide a tracking system for the retrieval of analytical and field data on each sample. Sample identification numbers will be used on all sample labels or tags, field data sheets or logbooks, COC records, and all other applicable documentation used during each project.

B.4.2.3 Documentation Procedures

Labels will be affixed to all sample containers during sampling activities. Some information may be pre-printed on each sample container label. Information that is not pre-printed will be

recorded on each sample container label at the time of sample collection. The information to be recorded on the labels includes the following:

- Contractor name
- Sample identification number
- Sample type (discrete or composite)
- Site name and sample station number
- Analysis to be performed
- Type of chemical preservative in container
- Date and time of sample collection
- Sampler's name and initials.

Sample logbooks and COC records will contain the same information as the labels affixed to the containers, along with sample location measurements. These records will be maintained and will document all information related to the sampling effort and the process employed. The tracking procedure to be used for documentation of all samples collected during the project field effort is outlined in the ERM Program Plan.

B.4.3 Field Variance System

Variances from the sampling procedures, ERM Program Plan, and/or SSHP will be documented on a Field Change Request (FCR) form or an NCR, as appropriate. If a variance is anticipated (e.g., because of a change in the field instrumentation), the applicable procedure will be modified and approved by the QA/QC Manager and the change noted in the field logbooks.

FCRs and NCRs are processed in accordance with SAIC Field Technical Procedures.

B.5 SAMPLE CUSTODY AND HOLDING TIMES

EPA policy regarding sample custody and COC protocols as described in *NEIC Policies and Procedures* (EPA 1985) will be implemented during the ERM program. This custody is in three parts: sample collection, laboratory analysis, and final evidence files. Final evidence files, including originals of laboratory reports and electronic files, are maintained under document control in a secure area. A sample or evidence file is under someone's custody when it is:

- In his/her possession
- In his/her view after being in his/her possession
- In his/her possession before he/she places the file in a secured location
- In a designated secure area.

B.5.1 Sample Documentation

The sample packaging and shipment procedures summarized in the following paragraphs will ensure that samples will arrive at the laboratory with the COC intact. The protocol for specific sample numbering using case numbers and traffic report numbers (if applicable) and other sample designations will be followed.

B.5.1.1 Field Procedures

The field sampler is responsible for the care and custody of the samples until they are transferred or properly dispatched. As few people as possible should handle the samples. Each sample container will be labeled with a sample number, date and time of collection, sampler, and sampling location. Sample labels are to be completed for each sample. The Field Manager, in conjunction with QA/QC Manager, will review all field activities to determine whether proper custody procedures were followed during the fieldwork and to decide if additional samples are required.

B.5.1.2 Field Logbooks/Documentation

Samples will be collected following the sampling procedures documented in the ERM Program Plan. When a sample is collected or a measurement is made, a detailed description of the location will be recorded. The equipment used to collect samples will be noted, along with the time of sampling, sample description, depth at which the sample was collected, volume, and number of containers. A sample identification number will be assigned before sample collection. Field duplicate samples and QA split samples, which will receive an entirely separate sample identification number, will be noted under sample description. Equipment employed to make field measurements will be identified along with their calibration dates.

B.5.1.3 Transfer of Custody and Shipment Procedures

Samples will be accompanied by a properly completed COC form. The sample numbers and locations will be listed on the COC form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record will document transfer of custody of samples from the sampler to another person, to a mobile laboratory, to the permanent laboratory, or to/from a secure storage area.

All shipments will be accompanied by the COC record identifying the contents. The original record will accompany the shipment, and copies will be retained by the sampler for return to project management and the project file.

All shipments will be in compliance with applicable United States Department of Transportation regulations.

B.5.2 Laboratory Chain of Custody Procedures

Custody procedures, along with the holding time and preservative requirements for samples, will be described in laboratory QA Plans. These documents will identify the laboratory custody procedures for sample receipt and log-in, sample storage, tracking during sample preparation and analysis, and laboratory storage of data.

B.5.2.1 Cooler Receipt Checklist

The condition of shipping coolers and enclosed sample containers will be documented upon receipt at the analytical laboratory. This documentation will be accomplished using the cooler receipt checklist. A copy of the checklist will be faxed to the Field Manager immediately after it has been completed at the laboratory. The original completed checklist will be transmitted with the final analytical results from the laboratory.

B.5.2.2 Letter of Receipt

The laboratory will confirm sample receipt and log-in information through transmission of a letter of receipt (LOR) to the QA/QC Manager. This transmission will include returning a copy of the completed COC, a copy of the cooler receipt checklist, and confirmation of the analytical log-in indicating laboratory sample and sample delivery group numbers.

B.5.3 Final Evidence Files Custody Procedures

SAIC is the custodian of the evidence file for this project. The evidence file will include all relevant records, reports, logs, field notebooks, pictures, subcontract reports, correspondence, laboratory logbooks, and COC forms. The evidence file will be stored in a secure, limited-access area and under custody of the Project Manager or designee.

The analytical laboratory will retain all results, supporting QC, COCs, and original raw data for 7 years (both hard copy and electronic) in a secure, limited-access area and under custody of the Laboratory Project Manager.

B.6 ANALYTICAL PROCEDURES

All analytical samples collected during this investigation will be analyzed by laboratories that were reviewed and validated by the U.S. Army. QA split samples will be analyzed by the designated QA laboratory. Each laboratory supporting this work will provide statements of qualifications, including organizational structure, QA Manual, and SOPs.

B.6.1 Laboratory Analysis

Principal laboratory facilities will not subcontract or transfer any portion of this work to another facility, unless expressly permitted to do so in writing by the U.S. Army.

Any proposed changes to analytical methods specified require written approval from the SBCCOM RPO. All analytical method variations will be identified in field change records. These may be submitted for regulatory review and approval when directed by the SBCCOM RPO.

Laboratory SOPs must be adapted from and reference standard accepted methods and thereby specify the following:

- Procedures for sample preparation
- Instrument startup and performance check
- Procedures to establish the actual and required detection limits for each parameter
- Initial and continuing calibration check requirements
- Specific methods for each sample matrix type
- Required analyses and QC requirements.

B.6.2 Field Screening Analytical Protocols

Procedures for field measurement of activity levels are described in Section B.7 of this QAPP.

B.7 CALIBRATION PROCEDURES AND FREQUENCY

This section describes procedures for maintaining the accuracy of the instruments and measuring equipment that are used for conducting field tests and laboratory analyses. These instruments and equipment will be calibrated before each use or on a scheduled, periodic basis according to SAIC procedures based on manufacturer recommendations.

B.7.1 Field Instruments/Equipment

Instruments and equipment used to gather, generate, or measure environmental data will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications. All field instruments for this purpose will have unique identifiers. The SAIC Health Physicist, Field Manager, or their designee will be responsible for performing and documenting daily calibration/checkout records for instruments used in the field.

Equipment to be used during field sampling will be examined to certify that it is in operating condition. This will include checking the manufacturer's operating manual and instructions for each instrument to ensure that all maintenance requirements are being observed. Field notes from previous sampling trips will be reviewed so that the notation on any prior equipment problems will not be overlooked, and all necessary repairs to equipment will be carried out. Spare parts for maintenance or minor repairs and redundant equipment will be available to the sampling effort.

Calibration of field instruments is governed by the SOP for the applicable field analysis method and will be performed at the intervals specified in the SOP. If no SOP is available, calibration of field instruments will be performed at intervals specified by the manufacturer or more frequently as conditions dictate. Calibration procedures, frequency, and results will be recorded in a field logbook.

Field instruments will include hand-held exposure rate detectors for radioactivity screening levels and photoionization detectors for organic vapor detection. If an internally calibrated field instrument fails to meet calibration/checkout procedures, it will be returned for service and a backup instrument will be calibrated and used in its place.

Detailed instructions on the proper calibration and use of each field instrument follow the guidelines established by the manufacturer. The technical procedures for each instrument used on this project include the manufacturer's instructions detailing the proper use and calibration of each instrument.

Exposure rate meters will be checked daily by using sealed calibration source checks. Meters will be calibrated routinely, with calibration dates clearly identified on each instrument. All daily calibration check information will be recorded on the appropriate form.

B.7.2 Laboratory Instruments

Calibration of laboratory equipment will be based on approved written procedures. Records of calibration, repairs, or replacement will be filed and maintained by laboratory personnel performing QC activities. These records will be filed at the location where the work is performed and will be subject to QA audit. Procedures and records of calibration will follow laboratory-

specific QA plans reviewed by SBCCOM and the contractor. For analyses governed by SOPs, the appropriate SOP for the required calibration procedures and frequencies should be referenced.

Records of calibration will be kept as follows:

- Each instrument will have a record of calibration with an assigned record number.
- A label will be affixed to each instrument showing identification numbers, manufacturer, model numbers, date of last calibration, signature of calibrating analyst, and due date of next calibration. Reports and compensation or correction figures will be maintained with each instrument.
- A written step-wise calibration procedure will be available for each piece of test and measurement equipment.
- Any instrument that is not calibrated to the manufacturer's original specifications will display a warning tag to alert the analyst that the device is out of service until corrections can be made.

B.8 INTERNAL QUALITY CONTROL CHECKS

This section describes QC checks to be performed during field work and laboratory analyses of environmental samples.

B.8.1 Field Sample Collection

The assessment of field sampling precision and accuracy will be made by collecting field duplicates and MS/MSDs in accordance with the procedures described in the ERM Program Plan.

B.8.2 Field Measurement

QC procedures for most field measurements (e.g., activity levels, headspace) are limited to calibrating the instruments and checking the reproducibility of measurements by obtaining multiple readings on a single sample or standard. Section B.7 of this QAPP and the ERM Program Plan contain more details regarding these measurements.

B.8.3 Laboratory Analysis

To ensure the production of analytical data of known and documented quality, laboratories associated with the environmental sampling will implement all applicable method QC. Analytical QC procedures for this environmental sampling are specified in the individual method descriptions. These specifications include the types of QC checks normally required: method blanks, LCS, MS, MSD, calibration standards, internal standards, tracer standards, calibration check standards, and laboratory duplicate analysis.

B.8.3.1 Quality Assurance Program

The subcontracted analytical laboratory will have a written QA program that provides rules and guidelines to ensure the reliability and validity of work conducted at the laboratory.

Compliance with the QA program is coordinated and monitored by the laboratory's QA Department, which is independent of the operating departments.

Minimum project objectives for the laboratory QA program follow:

- Properly sub-sample, preserve, prepare, and store all samples and extracts.
- Maintain adequate custody records from sample receipt through reporting and archiving of results.
- Use properly trained personnel to analyze all samples by approved methods within holding times.
- Produce scientifically sound and legally defensible data with associated documentation to show that each system was calibrated and operating within precision and accuracy control limits.
- Accurately calculate, check, report, and archive all data using the Laboratory Information Management System.
- Document all the above activities so that all data can be independently validated.

All laboratory procedures are documented in writing as SOPs, which are approved, revised, and controlled by the QA Department. Internal QC measures for analysis will be conducted in accordance with their SOPs and as specified in the individual method requirements.

B.8.3.2 Quality Control Checks

Implementation of QC procedures during sample collection, analysis, and reporting ensures that the data obtained are adequate for their intended use. Analytical QC measures are used to determine if the analytical process is in control, as well as to determine the sample matrix effects on the data being generated. Both field QC and laboratory QC checks are performed throughout the project to document potential bias in the data and to establish a basis for using the results with confidence.

Specifications include the types of QC required (duplicates, sample spikes, surrogate spikes, reference samples, controls, blanks, etc.), the frequency for implementation of each QC measure, compounds to be used for sample spikes and isotopic tracers, and the acceptance criteria for the QC results.

Laboratories will provide documentation in each data package that both initial and ongoing instrument and analytical QC functions have been met. Any non-conforming analysis will be reanalyzed by the laboratory if sufficient sample volume is available. It is expected that sufficient sample volumes will be collected to provide for reanalysis if required.

Analytical Process Quality Control

QC procedures are described in the following paragraphs for method and extraction blanks and laboratory control samples.

Method and Extraction Blanks

A method blank is a sample of an analyte-free substance similar to the matrix of interest (usually distilled/deionized water or silica sand) that is subjected to all of the sample preparation (digestion, distillation, extraction) and analytical methodology applied to the samples. The purpose of the method blank is to check for contamination from within the laboratory that might be introduced during sample preparation and analysis that would adversely affect analytical results. A method blank must be analyzed with each analytical sample batch. An extraction blank specifically monitors contamination that may be introduced during the extraction step for certain methods. An extraction blank must be analyzed for each extraction batch.

Laboratory Control Samples

The LCS contains known concentrations of specified target analytes and is carried through the entire preparation and analysis process. Commercially available LCSs or those from EPA may be used. LCS standards prepared in-house must be made from a source independent of that of the calibration standards. Each LCS analyte must be plotted on a control chart. The primary purpose of the LCS is to establish and monitor the laboratory's analytical process control. An LCS must be analyzed with each analytical sample batch.

Matrix and Sample-Specific Quality Control

Matrix and sample-specific QC procedures are outlined in this section.

Laboratory Duplicates

Laboratory duplicates are separate aliquots of a single sample that are prepared and analyzed concurrently at the laboratory. The duplicate sample must be selected from one of the project's environmental media samples (not a blank). The primary purpose of the laboratory duplicate is to check the precision of the laboratory analyst, the sample preparation methodology, and the analytical methodology. If there are significant differences among the duplicates, the affected analytical results will be reexamined. One in 20 samples will be a laboratory duplicate, with fractions rounded to the next whole number.

Surrogate Spikes

A surrogate spike is prepared by adding a pure compound to a sample before extraction. The compound in the surrogate spike should be of a similar type to that being assayed in the sample. The purpose of a surrogate spike is to determine the efficiency of recovery of analytes in the sample preparation and analysis. The percent of recovery of the surrogate spike is then used to gauge the total accuracy of the analytical method for that sample.

Isotopic Tracers

An isotopic tracer is prepared by adding a unique isotope of the same or similar element to a sample before preparation and analysis. The purpose of this isotopic tracer is to determine the efficiency of recovery of the targeted isotope or isotopes in the sample preparation and analysis. The percent of recovery of the tracer is then used to gauge the total accuracy of the analytical method for that sample and to compensate for the effect of efficiency variations on the quantification of radiochemical activity.

Matrix Spikes and Matrix Spike Duplicates

An MS is an aliquot of a sample spiked with known quantities of specified target analytes and subjected to the entire analytical procedure. It is used to measure method accuracy and to indicate matrix effects. An MSD is a second aliquot of the same sample spiked with known quantities of the same compounds. The purpose of the MSD, when compared to the MS, is to determine precision for the method, field procedures, and matrix. MSs and MSDs are analyzed at a minimum frequency of 1 per 20 samples of a similar matrix.

Method-Specific Quality Control

The laboratory must follow specific quality processes as defined by the method. These include measures such as calibration verification samples, instrument blank analysis, internal standards implementation, tracer analysis, method of standard additions utilization, serial dilution analysis, post-digestion spike analysis, and chemical carrier evaluation.

B.8.3.3 Split Samples

Field QA split samples will be collected as collocated or homogenized replicates of field samples and distributed to a designated QA laboratory for analysis, subject to the direction of the U.S. Army SBCCOM. These analyses will allow detection of problems with field sampling, documentation, packaging, or shipping. This approach, if implemented, will allow SBCCOM to check the primary analytical results, sensitivity, accuracy, and precision. These QA split samples will be collected and analyzed at a frequency of 5 percent, or a minimum of one split sample per matrix sampled.

B.8.3.4 Temperature Blank Samples

A temperature blank is a container of water packaged along with field samples in the shipment cooler that will represent the temperature of the incoming cooler upon receipt at the laboratory. Use of these samples within a shipping container enables the receiving laboratory to assess the temperature of the shipment without disturbing any project field samples. The contract laboratory will provide a temperature blank with each cooler.

B.9 CALCULATION OF DATA QUALITY INDICATORS

The approach to assessing the quality of field (Section B.9.1) and analytical data (Section B.9.2) is defined in this section. Sections B.9.3 and B.9.4, respectively, address project completeness and the representativeness and comparability of the data.

B.9.1 Field Measurements Data

Field data will be assessed by the Field Manager or his/her designee. The field results will be reviewed for compliance with the established QC criteria specified in this QAPP and the ERM Program Plan. Accuracy of the field measurements will be assessed using daily instrument calibration and calibration checks. Precision will be assessed on the basis of reproducibility by multiple readings of a single sample.

Field data completeness will be calculated using Equations (1a) and (1b).

Sample Collection (1a):

$$Completeness = \frac{Number\ of\ \ Sample\ Points\ Sampled}{Number\ of\ \ Sample\ Points\ Planned}\ x\ 100\% \qquad \textbf{(1a)}$$

Field Measurements (1b):

$$Completeness = \frac{Number\ of\ Valid\ Field\ Measurements\ Made}{Number\ of\ \ Field\ Measurements\ Planned}\ x\ 100\% \qquad \textbf{(1b)}$$

B.9.2 Laboratory Data

Laboratory results will be assessed for compliance with required precision, accuracy, completeness, and sensitivity as described in the following paragraphs.

B.9.2.1 Precision

The precision of the laboratory analytical process will be determined through evaluation of LCS analyses. The standard deviation of these measurements over time will provide confidence that implementation of the analytical protocols was consistent and acceptable. These measurements will establish the precision of the laboratory analytical process.

Environmental sample matrix precision will be assessed by comparing the analytical results between laboratory duplicates and field duplicates for each analytical parameter. The RPD will be calculated for each pair of duplicate analysis using Equation (2) below and will produce an absolute value for RPD. This precision measurement is impacted by variables associated with the analytical process, influences related to sample matrix interferences, consistent implementation of sampling procedures, and degree of sample homogeneity.

$$RPD = \frac{S - D}{\frac{(S + D)}{2}}\ x\ 100, \qquad \textbf{(2)}$$

where

S = First sample value (original value)
D = Second sample value (duplicate value).

B.9.2.2 Accuracy

The accuracy of the laboratory analytical measurement process will be determined by comparing the percent recovery for the LCS versus its documented true value.

Environmental sample accuracy will be assessed for compliance with the established QC criteria that are described in Section B.3 of this QAPP using the analytical results of method blanks, reagent/preparation blank, MS/MSD samples, and field blanks. The percent recovery (%R) of MS samples will be calculated using Equation (3) below. This accuracy measurement is

impacted by variables associated with the analytical process, influences related to sample matrix interferences, consistent implementation of sampling procedures, and degree of sample homogeneity.

$$\%R = \frac{A - B}{C} \, x \, 100, \qquad \textbf{(3)}$$

where

A = The analyte concentration determined experimentally from the spiked sample
B = The background level determined by a separate analysis of the unspiked sample
C = The amount of the spike added.

B.9.2.3 Completeness

Data completeness of laboratory analyses will be assessed for compliance with the amount of data required for decision-making. The completeness is calculated using Equation (4) below.

$$Completeness = \frac{Number\ of\ Valid\ Laboratory\ Measurements\ Made}{Number\ of\ Laboratory\ Measurements\ Planned} \, x \, 100\% \qquad \textbf{(4)}$$

B.9.2.4 Sensitivity

Achieving method detection limits (MDLs) depends on sample preparation techniques, instrument sensitivity, and matrix effects. Therefore, it is important to determine actual MDLs through the procedures outlined in 40 CFR 136, Appendix C. MDLs will be established for each major matrix under investigation (i.e., water, sediment [soil]) through multiple determinations, leading to a statistical evaluation of the MDL.

It is important to monitor instrument sensitivity through calibration blanks and low concentration standards to ensure consistent instrument performance. It also is critical to monitor the analytical method sensitivity through analysis of method blanks, calibration check samples, and LCSs.

B.9.3 Project Completeness

Project completeness will be determined by evaluating the planned versus actual data. Adjustments will be made if project field changes alter planned sample numbers during ERM implementation. All data not flagged as rejected by the review, verification, validation, or assessment processes will be considered valid. Overall, the project completeness will be assessed relative to media, analyte, and area of investigation. Completeness objectives are listed in **Table B-1**.

B.9.4 Representativeness/Comparability

Representativeness is the term most concerned with the proper design of the sampling program. Representativeness qualitatively expresses the degree to which data accurately reflect site conditions. Factors that affect the representativeness of analytical data include appropriate sample population definitions, proper sample collection and preservation techniques, analytical holding times, use of standard analytical methods, and determination of matrix or analyte interferences. Sample collection, preservation, analytical holding time, analytical method application, and matrix interferences will be evaluated by reviewing project documentation and QC analyses.

Comparability is a qualitative term that relates a project data set to other data sets. This investigation will employ narrowly defined sampling methodologies, site audits/surveillances, use of standard sampling procedures and equipment, uniform training, documentation of sampling, standard analytical protocols/procedures, QC checks with standard control limits, and universally accepted data reporting units to ensure comparability to other data sets. Through proper implementation and documentation of these standard practices, the project will establish confidence that data will be comparable to other project and programmatic information.

Additional input to determine representativeness and comparability may be gained through statistical evaluation of data populations, compound evaluations, or dual measurement comparisons.

B.10 CORRECTIVE ACTIONS

Corrective actions may be required for two major types of problems: analytical/equipment problems and non-compliance with criteria. Analytical and equipment problems may occur during sampling, sample handling, sample preparation, laboratory instrumental analysis, and data review.

Non-compliance with specified criteria and analytical/equipment problems will be documented through a formal corrective action program at the time the problem is identified. The person identifying the problem is responsible for notifying the SAIC Project Manager, who will notify the SBCCOM RPO. When the problem is analytical in nature, information on the problem will be communicated promptly to the SAIC QA/QC Manager. Implementation of corrective action will be confirmed in writing.

Any non-conformance with the established QC procedures in the QAPP or ERM Program Plan will be identified and corrected in accordance with the QAPP. The Project Manager or his/her designee will issue an NCR for each non-conforming condition.

Corrective actions will be implemented and documented in the field record book. No staff member will initiate corrective action without prior communication of findings through the proper channels. If corrective actions are deemed insufficient, work may be stopped through a stop-work order issued by the Project Manager and/or the SBCCOM RPO.

B.10.1 Sample Collection/Field Measurements

Technical staff and project personnel will be responsible for reporting all suspected technical and QA non-conformance or suspected deficiencies of any activity or issued document by reporting the situation to the Project Manager or his/her designee. The Project Manager will be responsible for assessing the suspected problems in consultation with the QA/QC Manager and Field Manager to make a decision based on the potential for the situation to impact data quality. If the situation warrants a reportable non-conformance and corrective action, the Project Manager will complete an NCR.

The Project Manager will be responsible for ensuring that corrective actions for non-conformance are initiated by the following:

- Evaluating all reported non-conformance
- Controlling additional work on non-conforming items

- Determining disposition or action to be taken
- Maintaining a log of non-conformance
- Reviewing NCRs and corrective actions taken
- Ensuring that NCRs are included in the final site documentation project files.

If appropriate, the Project Manager will ensure that no additional work dependent on the non-conforming activity is performed until the corrective actions are completed.

Corrective action for field measurements may include the following:

- Repeating the measurement to check the error
- Checking for all proper adjustments for ambient conditions, such as temperature
- Checking the batteries
- Recalibrating equipment
- Checking the calibration
- Modifying the analytical method, including documentation and notification (i.e., standard additions)
- Replacing the instrument or measurement devices
- Stopping work (if necessary).

The Project Manager or his/her designee is responsible for all site activities. In this role, he/she at times may be required to adjust the site activities to accommodate activity-specific needs. When it becomes necessary to modify an activity, the responsible person notifies the Project Manager of the anticipated change and implements the necessary change after obtaining the approval of the SAIC Project Manager and the SBCCOM RPO. All such changes will be documented on an FCR that will be signed by the initiators and the Project Manager. The FCR for each document will be numbered serially as required. The FCR will be attached to the file copy of the affected document. The Project Manager must approve the change in writing or verbally before field implementation. If unacceptable, the action taken during the period of deviation will be evaluated in order to determine the significance of any departure from established program practices and actions taken.

The Project Manager for the site is responsible for controlling, tracking, and implementing the identified changes. Reports on all changes will be distributed to all affected parties, including the SBCCOM RPO. The SBCCOM RPO will be notified whenever program changes in the field are made.

B.10.2 Laboratory Analyses

Laboratory QA plans will provide systematic procedures to identify out-of-control situations and document corrective actions. Corrective actions will be implemented to resolve problems and restore malfunctioning analytical systems. Laboratory personnel will receive QA training and be made aware that corrective actions are necessary for the following situations:

- QC data are outside warning or control windows for precision and accuracy.
- Blanks contain target analytes above acceptable levels and must be investigated.
- Undesirable trends are detected in spike recoveries or RPD between duplicates.

- There are unusual changes in detection limits.
- Deficiencies are detected by internal audits, external audits, or performance evaluation sample results.
- Inquiries concerning data quality are received.

Corrective action procedures often are handled at the bench level by the analyst who reviews the preparation or extraction procedure for possible errors and checks such factors as instrument calibration, spike and calibration mixes, and instrument sensitivity. If the problem persists or cannot be identified, the matter is referred to the Laboratory Supervisor, Manager, and/or QA Department for further investigation. When resolved, full documentation of the corrective action procedure is filed with project records and the laboratory QA Department, and the information is summarized within case narratives.

Corrective actions may include, but are not limited to, the following:

- Reanalyzing the samples if holding time criteria permit
- Evaluating blank contaminant sources, eliminating these sources, and reanalyzing
- Modifying the analytical method (i.e., standard additions) with appropriate notification and documentation
- Resampling and analysis
- Evaluating and amending sampling procedures
- Accepting data and acknowledging the level of uncertainty.

If resampling is deemed necessary due to laboratory problems, the Project Manager will identify the necessary recovery approach to implement the additional sampling effort.

The following corrective action procedures will be required:

- Problems noted during sample receipt will be documented in the appropriate laboratory LOR. The QA/QC Manager, Project Manager, and SBCCOM RPO will be contacted immediately to determine problem resolution. All corrective actions will be documented thoroughly.

- When sample extraction/digestion or analytical holding times are not within method-required specifications, the QA/QC Manager, Project Manager, and SBCCOM RPO will be notified immediately to determine problem resolution. All corrective actions will be documented thoroughly.

- All initial and continuing calibration sequences that do not meet method requirements will result in a review of the calibration. When appropriate, reanalysis of the standards or reanalysis of the affected samples back to the previous acceptable calibration check is warranted.

- All appropriate measures will be taken to prepare and clean up samples in an attempt to achieve the practical quantitation limits as stated. When difficulties arise in achieving these limits, the laboratory will notify the QA/QC Manager, Project Manager, and

SBCCOM RPO to determine problem resolution. All corrective actions will be documented thoroughly.

- Any dilutions impacting the practical quantitation limits will be documented in case narratives along with revised quantitation limits for those analytes affected. Analytes detected above the method detection limits, but below the practical quantitation limits, will be reported as estimated values.

- Failure of method-required QC to meet the requirements specified in this project QAPP will result in review of all affected data. Resulting corrective actions may encompass those identified earlier. The QA/QC Manager, Project Manager, and SBCCOM RPO will be notified as soon as possible to discuss possible corrective actions, particularly when unusual or difficult sample matrices are encountered.

- When calculation and reporting errors are noted within any given data package, reports will be reissued with applicable corrections. Case narratives will clearly state the reasons for reissuance of reports.

B.11 DATA REDUCTION, VALIDATION, AND REPORTING

The procedures for data reduction, validation, and reporting are discussed in Sections B.11.1–B.11.3, respectively.

B.11.1 Data Reduction

Data reduction protocols for field measurements and analytical data are addressed in this section.

B.11.1.1 Field Measurements

Raw data from field measurements and sample collection activities will be recorded appropriately in field logbooks. Data to be used in project reports will be reduced and summarized. The methods of data reduction will be documented.

The Field Manager or his/her designee is responsible for data review of all field-generated data. This includes verifying that all field descriptive data are recorded properly, that all field instrument calibration requirements have been met, that all field QC data have met frequency and criteria goals, and that field data are entered accurately in all applicable logbooks and worksheets.

B.11.1.2 Analytical Laboratory Data

All analytical samples collected for this investigation will be sent to U.S. Army qualified laboratories. Data reduction, evaluation, and reporting for samples analyzed by a laboratory will be performed according to specifications outlined in the laboratory's QA plan. Laboratory reports specifically will include documentation verifying analytical holding time compliance.

The Laboratory QA Manager is responsible for assessing data quality and informing the QA/QC Manager, Project Manager, and SBCCOM RPO of any data that are considered unacceptable or require caution on the part of the data user in terms of their reliability. Data will be reduced, evaluated, and reported as described in the laboratory QA plan.

The data review process will include identification of any out-of-control data points and data omissions, as well as interactions with the laboratory to correct data deficiencies. The Project Manager may elect to repeat sample collection and analyses based on the extent of the deficiencies and their importance in the overall context of the project. The laboratory will provide flagged data to include such items as (1) concentration below required detection limit, (2) estimated concentration due to poor spike recovery, and (3) concentration of chemical also found in the laboratory blank.

Laboratories will prepare and retain full analytical and QC documentation for the project. Such retained documentation will be both hard (paper) copy and electronic storage media (e.g., magnetic tape) as dictated by the analytical methodologies employed. As needed, laboratories will supply hard copies of the retained information.

Laboratories will provide the following information in each analytical data package submitted:

- Cover sheets listing the samples included in the report and narrative comments describing problems encountered in analysis
- Tabulated results of radionuclide and miscellaneous parameters identified and quantified
- Analytical results for QC sample spikes, sample duplicates, initial and continuing calibrations, verifications of standards and blanks, standard procedural blanks, LCSs, and other deliverables as identified in Section B.11.3 of this QAPP
- Tabulation of water analysis instrumentation detection limits determined in pure water.

B.11.2 Data Validation

Data validation procedures are specified in this section.

B.11.2.1 Data Validation Approach

A systematic process for data verification and validation will be performed to ensure that the precision and accuracy of the analytical data are adequate for their intended use. The greatest uncertainty in a measurement is often a result of the sampling process and inherent variability in the environmental media rather than the analytical measurement. Therefore, analytical data validation will be performed only to the level necessary to minimize the potential of using false positive or false negative results in the decision-making process (i.e., to ensure accurate identification of detected versus non-detected compounds). This approach is consistent with the DQOs for the project, with the analytical methods, and for determining contaminants of concern and calculating risk.

Samples will be analyzed through implementation of definitive analytical methods. Definitive data will be reported consistent with the deliverables identified in Section B.11.3 of this QAPP. This report content is consistent with what is understood as an EPA Level III deliverable (data forms including laboratory QC and calibration information). This definitive data then will be validated through the review process presented in Section B.11.2. DQOs

identified in Section B.3 and method-specified criteria will be validated. Comprehensive analytical information will be retained by the subcontract laboratory.

Validation will be accomplished by comparing the contents of the data packages and QA/QC results to requirements contained in the requested analytical methods. The QA/QC Manager will be responsible for these activities. The protocol for analyte data validation is presented in the following:

- *SAIC Quality Assurance Procedures for Data Management* (SAIC 2003)
- *EPA National Functional Guidelines for Inorganic Data Review* (EPA 1994b).

The QA/QC Manager will conduct a systematic review of the data for compliance with the established QC criteria based on the following categories:

- Holding times
- Blanks
- LCSs
- Surrogate recovery (organic methods)
- Internal standards (primarily organic methods)
- Isotopic tracers (radionuclide methods)
- Inductively coupled plasma or atomic absorption QC
- Calibration
- Sample reanalysis
- Secondary dilutions
- Laboratory case narrative.

Consistent with the data quality requirements as defined in the DQOs, all project data and associated QC will be evaluated according to these categories and qualified based on the outcome of the review.

B.11.2.2 Analytical Data Validation

Analytical data for each sampling event will be verified electronically and validated by qualified chemists. Flags signifying the usability of data will be noted and entered into an analytical database. Deficiencies in data deliverables will be corrected through direct communication with the field or laboratory, generating immediate response and efficient resolution. All significant data discrepancies noted during the validation process will be documented through NCRs, which are sent to the laboratory for clarification and correction.

Decisions to repeat sample collection and analyses may be made by the QA/QC Manager, Project Manager, and SBCCOM RPO based on the extent of the deficiencies and their importance in the overall context of the project.

All data generated for environmental sampling will be computerized in a format organized to facilitate data review, evaluation, and reporting. The computerized data set will include data flags in accordance with the above-referenced protocols.

The JPG data assessment will be accomplished by the joint efforts of the QA/QC Manager, Project Manager, and Field Manager. Data assessment will be based on the criterion that the sample was properly collected and handled according to the ERM Program Plan and Sections B.4 and B.5 of this QAPP. An evaluation of data accuracy, precision, sensitivity, and completeness, based on criteria in Section B.9 of this QAPP, will be performed by a data assessor. This data quality assessment will indicate that data are (1) usable as a quantitative concentration, (2) usable with caution as an estimated concentration, or (3) unusable due to out-of-control QC results.

The environmental data sets will be available for controlled access by the Project Manager and authorized personnel. Data will be incorporated into summary reports as required.

B.11.3 Data Reporting

Laboratories will prepare and submit analytical and QC data reports to SAIC and SBCCOM RPO in compliance with the requirements of this QAPP. The laboratory will be required to confirm sample receipt and login information. The laboratory will return a copy of the completed COC and confirmation of the laboratory's analytical login to the SBCCOM RPO within 24 hours of sample receipt.

The subcontract analytical laboratory will prepare and retain full analytical and QC documentation for 7 years. Such retained documentation will include all hard copies and other storage media (e.g., magnetic tape). As needed, the subcontract analytical laboratory will make available all retained analytical data information.

B.12 PREVENTIVE MAINTENANCE PROCEDURES

The field equipment for this project may include alpha/beta and gamma exposure rate survey meters. Specific preventive maintenance procedures to be followed for field equipment are those recommended by the manufacturers. These procedures are included in the technical procedures governing the use of these instruments.

Field instruments will be checked and/or calibrated before they are shipped or carried to the field. Each field instrument will be checked daily against a traceable standard or reference with a known value to ensure that the instrument is in proper calibration. Instruments found to be out of calibration will be recalibrated before use in the field. If an instrument cannot be calibrated, it will be tagged for return to the supplier or manufacturer for recalibration. A backup instrument will be used in its place. Calibration checks and calibrations will be documented on the Field Meter/Calibration Log Sheets. Any maintenance conducted on field equipment also must be documented in the logbook.

Critical spare parts such as batteries will be kept onsite to minimize down time of malfunctioning instruments. Backup instruments and equipment should be available onsite or within 1-day shipment to avoid delays in field schedules.

B.13 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits of both field and laboratory activities will be conducted to verify that sampling and analysis are performed in accordance with the procedures established in

the ERM Program Plan and QAPP. Audits of laboratory activities may include both internal and external audits.

B.13.1 Field Audits

Internal audits of field activities (sampling and measurements) will be conducted by the QA/QC Manager and/or Field Manager. The audits will include examination of field sampling records, field instrument operating records, sample collection, handling and packaging in compliance with the established procedures, maintenance of QA procedures, and COC. These audits will occur at the onset of the project to verify that all established procedures are followed (systems audit).

Performance audits will follow to ensure that deficiencies have been corrected and to verify that QA practices/procedures are being maintained throughout the duration of the project. These audits will involve reviewing field measurement records, instrumentation calibration records, and sample documentation.

External audits may be conducted at the discretion of the SBCCOM RPO or NRC.

B.13.2 Laboratory Audits

The U.S. Army SBCCOM may conduct an independent onsite systems audit of an analytical laboratory. This system audit includes examining laboratory documentation of sample receiving, sample login, sample storage, COC procedures, sample preparation and analysis, and instrument operating records. Performance audits consist of sending performance evaluation samples to designated laboratories for ongoing assessment of laboratory precision and accuracy. The analytical results of the analysis of performance evaluation samples are evaluated to ensure that laboratories maintain acceptable performance.

System audits include examination of laboratory documentation of sample receiving, sample login, sample storage, COC procedures, sample preparation and analysis, and instrument and operating records. Internal performance audits also may be conducted on a regular basis. Single-blind performance samples are prepared and submitted along with project samples to a designated laboratory for analysis. The analytical results of these single-blind performance samples are evaluated to ensure that the laboratory maintains acceptable performance.

SAIC is not contracted to perform laboratory audits; however, an audit may be accommodated if requested by the SBCCOM RPO. External audits may be conducted in conjunction with or at the direction of the NRC.

B.14 QUALITY ASSURANCE REPORTS TO MANAGEMENT

QA reporting from the laboratory (Section B.14.1) and SAIC (Section B.14.2) is described in this section.

B.14.1 Quality Assurance Reports

Each laboratory will provide LORs and analytical QC summary statements (case narratives) with each data package. All COC forms will be compared with samples received by the laboratory, and a LOR will be prepared and sent to the QA/QC Manager describing any differences in the

COC forms and the sample labels or tags. All deviations will be identified on the receiving report, such as broken or otherwise damaged containers. This report will be forwarded to the SBCCOM RPO within 24 hours of sample receipt and will include the following: a signed copy of the COC form, itemized sample numbers, laboratory sample numbers, and itemization of analyses to be performed.

Any departures from approved plans will receive prior approval from the SBCCOM RPO and will be documented with FCRs. These FCRs will be incorporated into the project evidence file.

The SBCCOM RPO will maintain custody of the project evidence file and will maintain the contents of files for this project, including all relevant records, reports, logs, field logbooks, pictures, subcontract reports, correspondence, and COC forms. Analytical laboratories will retain all original analytical raw data information (both hard copy and electronic) in a secure, limited-access area.

B.14.2 Quality Control Summary Reports

At the conclusion of field environmental sampling activities and laboratory analysis, the QA/QC Manager will validate submitted data. This activity will include assignment of flags to data, documentation of the reason(s) for the assignments, and description of any other data discrepancies. The QA/QC Manager will then prepare a Quality Control Summary Report (QCSR), which will be included as an appendix to the final report. This report will be submitted to the SBCCOM RPO in accordance with the project schedule. The contents of the QCSR will include data validation documentation and discussion of all data that may have been compromised or influenced by aberrations in the sampling and analytical processes. Both field and laboratory QC activities will be summarized. Problems encountered, corrective actions taken, and their impact on project DQOs will be determined.

The following are examples of elements to be included in the QCSR as appropriate:

- Laboratory QC evaluation and summary of the data quality for each analytical type and matrix; summary of the accuracy, precision, and sensitivity from the data quality assessment

- Field QC evaluation and summary of data quality relative to data usability; summary of the accuracy, precision, and sensitivity from the data quality assessment

- Overall data assessment and usability evaluation

- QCSR consolidation and summary

- Summary of lessons learned during project implementation.

Specific elements to be evaluated within the QCSR include the following:

- Sample results
- Field and laboratory blank results
- Laboratory control sample percent recovery (method dependent)

- Sample MS percent recovery (method dependent)
- MS/MSD or sample duplicate RPD (method dependent)
- Analytical holding times
- Surrogate recovery when appropriate.

B.15 REFERENCES

EPA (U.S. Environmental Protection Agency) 1985. National Enforcement Investigations Center (*NEIC) Policies and Procedures*.

EPA 1991. Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans. QAMS-005/80.

EPA 1993. Data Quality Objectives Process. EPA-540-R-93-071. September.

EPA 1994a. EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations. EPA QA/R-5. January.

EPA 1994b. EPA National Functional Guidelines for Inorganic Data Review. EPA-540/R-94/013. February.

SAIC (Science Applications International Corporation) 2003. *SAIC Quality Assurance Procedures for Data Management.* Quality Assurance Program. Engineering and Environmental Management Group, Oak Ridge, Tennessee.

USACE (United States Army Corps of Engineers) 2001. Requirements for the Preparation of Sampling and Analysis Plans. EM 200-1-3. February.

APPENDIX C

SITE SAFETY AND HEALTH PLAN

ENVIRONMENTAL RADIATION MONITORING PROGRAM

TABLE OF CONTENTS

C. SITE SAFETY AND HEALTH PLAN C-1

C.1 INTRODUCTION C-1
C.1.1 General C-1
C.1.2 Site Description C-3

C.2 HAZARD/RISK ANALYSIS C-4
C.2.1 Task-Specific Hazard Analysis C-5
C.2.2 Potential Exposures C-5
C.2.3 General UXO Safety Guidelines C-5

C.3 STAFF ORGANIZATION AND RESPONSIBILITIES C-12

C.4 TRAINING C-13
C.4.1 Offsite Training C-14
C.4.2 Site Worker Training C-14
C.4.3 Site Visitor Training C-15
C.4.4 Documentation C-15

C.5 PERSONAL PROTECTIVE EQUIPMENT C-15
C.5.1 Types of Protective Equipment C-16
C.5.2 Cleaning, Storage, and Program Verification C-17

C.6 MEDICAL SURVEILLANCE C-17

C.7 RADIOLOGICAL PROTECTION C-17
C.7.1 Training C-17
C.7.2 Radiological Exposure Monitoring C-17

C.8 STANDARD OPERATING SAFETY PROCEDURES C-18
C.8.1 Site Rules C-18
C.8.2 Sources of Ignition and Fire Protection C-19
C.8.3 Electrical Safety C-19
C.8.4 Hazard Communication C-19
C.8.5 Sanitation C-20
C.8.6 Heat/Cold Stress C-20
C.8.7 Site Communication C-20

C.9 PERSONAL HYGIENE AND DECONTAMINATION C-21
C.9.1 Level D Protection Doffing Sequence C-21
C.9.2 Equipment Decontamination C-21

C.10 EMERGENCY PROCEDURES AND COMMUNICATION C-21
C.10.1 Emergency Procedures C-21
C.10.2 Emergency Equipment C-23

C.11 LOGS, REPORTS, AND RECORDKEEPING C-24

C.12 REFERENCES C-24

LIST OF FIGURES

C-1. Directions from Jefferson Proving Ground to King's Daughters' Hospital C-23

LIST OF TABLES

C-1. SSHP Accident Prevention Plan Information Jefferson Proving Ground, Indiana..... C-2
C-2. Historical Concentration of Depleted Uranium Jefferson Proving Ground, Indiana (1984-2000)..... C-4
C-3. Hazards Inventory Jefferson Proving Ground, Indiana..... C-4
C-4. Hazards Analysis Jefferson Proving Ground, Indiana C-6
C-5. Potential Chemical Exposures Jefferson Proving Ground, Indiana..... C-10
C-6. Roles and Responsibilities for the ERM Program Jefferson Proving Ground, Indiana..... C-12
C-7. Training Requirements Jefferson Proving Ground, Indiana C-13
C-8. Emergency Points of Contact Jefferson Proving Ground, Indiana C-22

LIST OF ACRONYMS

A1	confined human carcinogen
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
CFR	Code of Federal Regulations
CPR	cardiopulmonary resuscitation
CWM	chemical warfare material
cm	centimeter
DAC	derived air concentration
dBA	decibels (audible)
DU	depleted uranium
EC&HS	Environmental Compliance and Health and Safety (program)
EEMG	Engineering and Environmental Management Group
EPA	U.S. Environmental Protection Agency
ERM	environmental radiation monitoring
^{o}F	degrees Fahrenheit
FP	flash point
ft	foot
FTP	Field Technical Procedure
GFCI	ground fault circuit interrupter
GIS	geographical information system
HAZWOPER	hazardous waste operations and emergency response
HTRW	hazardous, toxic, and radioactive waste
IDLH	immediately dangerous to life and health
in.	inch
IP	ionization potential
JPG	Jefferson Proving Ground
kg	kilogram
km^2	square kilometer
kV	kilovolt
lb	pound
LEL	lower explosive limit
m	meter
µCi/ml	microcuries per milliliter

mg/m^3	milligrams per square meter
mi	mile [Did not find in text. Delete?]
mrem	millirem
NA	not applicable
NRC	Nuclear Regulatory Commission
MSDS	Material Safety Data Sheet
NIOSH	National Institute of Occupational Safety and Health
OEW	Ordnance and Explosive Waste
OJT	on-the-job training
OSHA	Occupational Safety and Health Administration
pCi/g	picocuries per gram
pCi/L	picocuries per liter
PEL	permissible exposure limit
PID	photoionization detector
PPE	personal protective equipment
ppm	parts per million
PVC	polyvinyl chloride
RPO	Radiation Protection Officer
RSO	Radiation Safety Officer
SAIC	Science Applications International Corporation
SBCCOM	Soldier and Biological Chemical Command
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
STEL	short-term exposure limit
TLV	threshold limit value
TWA	time-weighted average
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
UXO	unexploded ordnance
VP	vapor pressure

HEALTH AND SAFETY PLAN APPROVAL AND SIGN OFF

Site Name: Jefferson Proving Ground

Work Location: Madison, Indiana

I have read, understood, and agreed with the information set forth in this Health and Safety Plan.

Corinne Shea — 9-11-03

Corinne Shea — **Date**
Project Manager

Mark Peterson — 9-11-03

Mark Peterson — **Date**
Site Safety and Health Officer

Michael Cox — 9/11/03

Michael Cox — **Date**
Field Manager

This page intentionally left blank.

C. SITE SAFETY AND HEALTH PLAN

C.1 INTRODUCTION

C.1.1 General

Science Applications International Corporation (SAIC) maintains a corporate Environmental Compliance and Health and Safety (EC&HS) program intended to ensure safe operation and regulatory compliance. SAIC's EC&HS program document (SAIC 2003), together with site safety and health plans (SSHPs), present the requirements for safely performing field work.

This SSHP sets forth the basic procedures required to protect SAIC and subcontractor personnel involved in the field phase of this program. It also establishes practices to protect the public and the immediate environment from hazards caused by this work. SAIC personnel and subcontractors are required to review this plan prior to onsite ERM program participation. SAIC subcontractors are further required to verify that the hazard controls contained in this plan are sufficient to protect their employees and, if not, to supplement this plan with additional and sufficient controls. In addition, subcontractor personnel are required to submit certifications relating to their training and medical monitoring to SAIC to assure compliance with these requirements as detailed in this SSHP. Standard procedures will be used to minimize the potential for personnel injury or illness. These will include site-specific training, routine inspections, visual and instrument surveillance for hazards, and enforcement of the health and safety requirements by project management.

This document is designed to satisfy the requirements of ER 385-1-92, "Safety and Occupational Health Document Requirements for Hazardous, Toxic, and Radioactive Waste (HTRW) and Ordnance and Explosive Waste (OEW) Activities" (U.S. Army Corps of Engineers [USACE] 1994), EM-385-1-1, "U.S. Army Corps of Engineers Safety and Health Requirements Manual" (USACE 1996), "Radiation Protection Manual" (USACE 1997), relevant Occupational Safety and Health Administration (OSHA) regulations, and the SAIC EC&HS Manual and associated procedures (SAIC 2003).

This SSHP is included as an appendix to the Environmental Radiation Monitoring (ERM) Program Plan. In cases where required information is contained in the Environmental Sampling Plan, this information will be referenced rather than repeated in this SSHP. The ERM Program Plan contains information including detailed site descriptions and site maps. Both the applicable ERM Program Plan and this SSHP must be present onsite during field work.

Field work is proposed for the Jefferson Proving Ground (JPG) Depleted Uranium (DU) Impact Area in the areas identified for environmental sampling. Field tasks to be performed by SAIC and its subcontractors may include the following:

- External gamma exposure rate survey
- Collection of groundwater, surface water, and sediment samples
- Equipment decontamination
- Waste management.

The potential environmental contaminants are metals, explosives compounds, and DU. The primary physical hazards are associated with the sampling activities and the work environment. Based on the results of previous environmental sampling, concentrations of metals, explosives compounds, and DU (i.e., including daughters) are not great enough to pose an acute or immediate health threat to sampling personnel. At the low concentrations of the expected contaminants, there are no chemical hazards except possibly through the ingestion of large amounts of soils, sediments, surface water, and groundwater. The radiological hazards associated with shell fragments are considered low so long as they are not picked up and carried for a time by personnel. The primary potential routes of exposure are the dermal and ingestion pathways. Inhalation exposure should be minimal because all sampling locations are outdoors and are well ventilated. Also, general site and sampling activities are not anticipated to generate dust.

This project will be performed in Level D and Modified Level D personal protective equipment (PPE) unless one of several action levels specified in the plan is exceeded or the potential for increased risk becomes apparent during the field activities. Protective procedures, including protective clothing, will be upgraded as necessary by the Site Safety and Health Officer (SSHO) based on established action levels or judgment. Changes will be documented with SSHP addenda, field change orders, radiation safety permits, or equivalents.

Environmental Manual EM-385-1-1 (USACE 1996) requires specific items of information to be included in a Project Accident Prevention Plan. **Table C-1** provides the locations of these specific items within SAIC's program documents and this SSHP.

Table C-1. SSHP Accident Prevention Plan Information
Jefferson Proving Ground, Indiana

Requirement	Location of Information
Signature sheet	SSHP inside front cover
Background information	SSHP front cover and Introduction
Statement of safety and health policy	EC&HS Program Manual [a]
Responsibilities and lines of authority	SSHP Section C.3
Subcontractors and suppliers	SSHP Section C.3
Training	EC&HS Procedure 20 [a] and SSHP Section C.4
Safety and health inspections	SSHP Section C.3
Safety and health expectations, incentive programs, and compliance	EC&HS Policy Statement and EC&HS Program Implementation Guide [a]
Accident reporting	EC&HS Procedures 4 and 6 [a] and SSHP Sections C.7, C.8, and C.10
Medical support	SSHP Section C.10
Personal protective equipment	SSHP Section C.5
Emergency response	SSHP Section C.10
Contingency plans	SSHP Section C.10
Job cleanup and safe access	SSHP Section C.8
Public safety requirements	SSHP Introduction and Sections 8 and 11
Local requirements	None
Prevention of alcohol/drug abuse on the job	SAIC Policy A18 Drug and Substance Abuse [a]
Hazard communication	EC&HS Procedure 8 [a] and SSHP Sections C.4, C.8.4, and C.10

[a] SAIC 2003.
EC&HS = Environmental Compliance and Health and Safety
SAIC = Science Applications International Corporation
SSHP = Site Safety and Health Plan

C.1.2 Site Description

This section provides information on the site, including the site history (Section C.1.2.1) and the nature and extent of contamination (Section C.1.2.2).

C.1.2.1 Site History

JPG, located in Madison, Indiana, was used as a proving ground from 1941 to 1994. During this time, more than 24 million rounds of conventional explosive ammunition were fired. Approximately 1.5 million rounds did not detonate upon impact, remaining as unexploded ordnance (UXO) either on or beneath the ground surface. As part of its munitions testing program, the JPG test-fired DU projectiles. The DU test firings were conducted under a license issued by the Nuclear Regulatory Commission (NRC) [License SUB-1435, Docket 040-08838]. The test firing of DU projectiles occurred between 1983 and 1994.

Approximately 220,462 pounds (lbs) (100,000 kilograms [kg]) of DU projectiles were fired at soft targets in a 2,080-acre (8.4-square kilometer [km^2]) DU Impact Area. Approximately 66,139 lbs (30,000 kg) of DU projectiles and projectile fragments were recovered. Approximately 154,323 lbs (70,000 kg) of DU remain in the DU Impact Area.

The DU Impact Area is approximately 17,283 feet (ft) (5,268 meters [m]) long and 5,240 ft (1,597 m) wide and covers an area of approximately 2,080 acres (8.4 km^2). The northern and southern boundaries of the DU Impact Area are F Road and slightly south of C Road, respectively. Morgan Road and Wonju Road form the western and eastern boundaries, respectively.

C.1.2.2 Nature and Extent of Contamination

The distribution of this DU is non-homogeneous because of the variability in the projectile trajectory and projectile fragmentation. The initial non-homogeneous deposition of DU as metal remains non-homogeneous as the DU metal oxidizes with time. The highest concentrations of DU in the soil have been from samples taken from directly under projectiles or projectile fragments. In these cases, the DU concentration in the soil in the top 5.9 inches (in) [15 centimeters (cm)] under a penetrator or penetrator fragment can be thousands of picocuries per gram (pCi/g). The DU concentrations decrease with depth, and at depths greater than approximately 2 ft (61 cm), DU concentrations are comparable to background. Also, the DU concentration decreases with horizontal distance from penetrator fragments, and at distances greater than 1 ft (30 cm), it typically is at background concentrations.

Under the ERM program, environmental media have been monitored to determine the presence or absence of DU-related contamination from past operations. **Table C-2** presents median concentrations of DU-related contamination for soil, sediment, surface water, and groundwater. Sections 2 and 3 of the ERM Program Plan contain additional information on this program.

Table C-2. Historical Concentration of Depleted Uranium
Jefferson Proving Ground, Indiana (1984-2000)

Isotope	Median Concentration	Medium
DU	0.86 pCi/g[a]	Soil
DU	18.8 pCi/g	Sediments
Total uranium	2.7 pCi/L	Surface water
Total uranium	1.6 pCi/L	Groundwater

[a] Average value
DU = depleted uranium
pCi/g = picocuries per gram
pCi/L = picocuries per liter

C.2 Hazard/Risk Analysis

The purpose of this site task hazard analysis is to identify and assess potential hazards that may be encountered by site personnel and to prescribe required controls. **Table C-3** is a checklist of common hazards that may be posed by this type of project. It includes negative declarations for hazards that will not be encountered.

Table C-3. Hazards Inventory
Jefferson Proving Ground, Indiana

Yes	No	Hazard
X		Biological hazards (bees, ticks, wasps, poison ivy)
	X	Confined space entry (potential for entry)
	X	Drowning
X		Electrical shock
	X	Excavation entry (excavations will not be entered)
X		Exposure to chemicals
X		Fire
X		Unexploded ordnance
	X	Heavy equipment
X		Noise
X		Radiation or radioactive contamination
X		Temperature extremes
X		Lifting
	X	Falls from elevated surfaces
X		Inclement weather

Because surface soils, subsurface soils, and sediments at JPG may be contaminated with DU, there is some potential for exposure to ionizing radiation. Site tasks also present a variety of possible physical hazards, with water, sediment, and soil sampling operations offering the greatest potential for significant injury. Physical hazards include falling, entanglement with equipment, uneven ground, fire, heavy lifting/moving, and inclement weather. If additional tasks or significant hazards are encountered during the work, this document will be modified by addendum or field change order to include the additional information.

C.2.1 Task-Specific Hazard Analysis

Table C-4 presents task-specific hazards, task-specific hazard analyses, relevant hazard controls, and required monitoring, if appropriate, for all of the planned site tasks. The hazard analyses are derived through a qualitative risk assessment process using a matrix of probability codes and severity codes.

The probability codes are identified as high (likely to occur immediately), moderate (probably will occur in time), low (possibly will occur in time), and very low (unlikely to occur). The severity codes are high (injuries/illnesses involving permanent total disability or death), moderate (injuries/illnesses with permanent partial disability or temporary total disability), low (injuries/illnesses resulting in temporary, reversible conditions with a period of disability of less than 3 months), and very low (injuries/illnesses with no discernible effects or reversible adverse effects requiring only minor treatment).

The environmental sampling locations were cleared previously for UXO. However, the presence of UXO must be considered a possibility in the sampling areas. General UXO safety guidelines are presented in Section C.2.3 and are not included in **Table C-4**.

The primary activities to be carried out during environmental sampling at JPG include the following:

- External gamma exposure rate measurements
- Collection of groundwater, surface water, and sediment samples
- Equipment decontamination
- Waste management.

These activities present a potential for exposure to chemical and radiological contaminants, as well as a variety of physical hazards.

C.2.2 Potential Exposures

Information on the significant suspected contaminants and chemical tools that will be used for the project is contained in **Table C-5**. Note that this list does not include all the contaminants that have been detected. Only those contaminants with relatively low exposure limits and that are present in relatively large concentrations are listed in **Table C-5**. If additional contaminants or chemical tools that pose new or significantly greater hazards are identified prior to or during site activities, they will be provided as an addendum to this document.

C.2.3 General UXO Safety Guidelines

Although the environmental sampling areas and associated routes have been cleared of UXO, general UXO information is presented in Section C.2.3.1 . The target area, impact area, ricochet area, and surrounding areas may contain UXO. UXO may be found on the surface and/or subsurface. The varying types of ammunition, angle of fire, and soil types preclude the accurate estimation of the depth of any subsurface UXO.

Table C-4. Hazards Analysis
Jefferson Proving Ground, Indiana

Safety and Health Hazards	Probability/Severity	Controls	Monitoring
Soil and Sediment Sampling			
General safety hazards (moving equipment, lifting, slips, falls)	Low/low	Level D PPE (see Section 5.0), plus hard hat and buddy system. No employees under lifted loads. Lifts of >50 lbs will be performed by two or more personnel or using mechanical assistance; extensive heavy lifting will require additional lifting training. HAZWOPER 40-hour training and standard procedures apply.	Daily safety inspections.
Noise	Low/low	None, unless SSHO determines that equipment potentially exceeds 85 dBA.	Daily safety inspections.
Exposure to chemicals (see **Table C-5)**	Very low/very low	Modified Level D PPE, including nitrile or PVC gloves, as well as disposable shoe covers for contact with potentially contaminated material. Medical clearance for HAZWOPER work. Minimal contact, wash face and hands prior to taking anything by mouth.	Daily safety inspections.
Radiological hazards	Refer to **Table C-5** and Section C.7.		
External exposure	Moderate/very low	Medical clearance for HAZWOPER work. If area dose rates are measurable, limit the time in the area. For samples, increase distance and provide shielding, as practical (ALARA).	Dose rate survey of work area prior to work.
Internal exposure	Low/low	Keep sample cuttings wet to minimize airborne exposure. Containerize or cover potentially contaminated material. Medical clearance for HAZWOPER work. Do not eat, drink, smoke, or chew in sampling area or prior to successful frisk. Do not touch face when handling potentially contaminated material. Respiratory protection if engineering controls insufficient. Exclusion zone around contaminated areas.	Visual survey. Dose rate survey.
Skin contamination	Low/very low	PPE Modified Level D. Nitrile (or equivalent) gloves, disposable shoe covers. Exclusion zone around contaminated areas.	Perform a whole body frisk upon exiting a potentially contaminated area (exclusion zone).
Temperature extremes	Low/low	Administrative controls. Shaded break area. Chilled drinks if temperature exceeds 70ºF. If impermeable clothing is worn, (1) a mandatory work/rest cycle will be announced and (2) workers will be notified to take unscheduled breaks if needed.	Temperature measurements at least twice per day and heart rate monitoring if personnel wear impermeable clothing.
Biological hazards (bees, ticks, Lyme disease, wasps, snakes)	Moderate/low	PPE (boots, work clothes). Insect repellant on boots and pants and elsewhere, as necessary. Pant legs tucked into boots or otherwise closed to minimize tick entry. Inspect for ticks during the day and at the end of each work day.	Visual survey.

Table C-4. Hazards Analysis
Jefferson Proving Ground, Indiana (Continued)

Safety and Health Hazards	Probability/Severity	Controls	Monitoring
Surface Water and Groundwater Sampling and Sample Preservation			
General safety hazards (moving equipment, lifting, slips, falls)	Low/low	Level D PPE: long pants, shirts with sleeves, safety glasses, safety shoes or boots, and hard hats if overhead hazards are present (buddy system). Lifts of >50 lbs will be performed by two or more personnel or with mechanical assistance; extensive heavy lifting will require additional lifting training. Hazardous waste safety training. Exclusion zone if there is a potential for unauthorized entry.	Daily site safety inspections.
Noise	Low/low	None, unless SSHO determines that equipment potentially exceeds 85 dBA.	Daily safety inspection.
Fire (fuels)	Low/moderate	Fuel stored in safety cans with flame arresters. Fire extinguisher in fuel use areas. No ignition sources in fuel storage areas. Bonding (metal to metal contact) during pouring. Gasoline-powered equipment shut down during fueling.	Daily site safety inspections.
Exposure to chemicals	Low/moderate	Level D PPE, including nitrile or PVC gloves to handle potentially contaminated material. Minimal contact, wash face and hands prior to taking anything by mouth. Medical clearance for HAZWOPER work. Fifteen-minute eyewash within 100 ft when pouring corrosive sample preservatives, eyewash bottle within 10 ft when adding water to pre-preserved sample containers. Site training must include hazards and controls of exposure to contaminants and chemicals used onsite. MSDSs kept onsite. All chemical containers labeled with contents and hazard.	Daily site safety inspections.
Electrical shock	Very low/high	Ground fault circuit interrupters will be used if electrical hand tools are used.	Visual survey of all work areas.
Temperature extremes	Low/low	Administrative controls. Shaded break area. Chilled drinks if temperature exceeds 70ºF. If impermeable clothing is worn, (1) a mandatory work/rest cycle will be announced and (2) workers will be notified to take unscheduled breaks if needed.	Temperature measurements at least twice per day and heart rate monitoring if personnel wear impermeable clothing.
Biological hazards (bees, ticks, Lyme disease, wasps, snakes)	Moderate/low	PPE (boots, work clothes). Insect repellant on boots and pants and elsewhere, as necessary. Pant legs tucked into boots or otherwise closed to minimize tick entry. Inspect for ticks during the day and at the end of each work day.	Visual survey.

Table C-4. Hazards Analysis
Jefferson Proving Ground, Indiana (Continued)

Safety and Health Hazards	Probability/Severity	Controls	Monitoring
Equipment Decontamination (hot water washing, soap and water washing, isopropyl alcohol washing)			
General equipment decontamination hazards (hot water, slips, falls, equipment handling)	Low/very low	Level D PPE.	Daily site safety inspections.
Steam/hot water	Low/low	Modified Level D PPE, including face shield, heavy duty PVC or similar gloves. Saranax suit, rain suit, or splash apron optional (when operating steam washer).	Daily site safety inspections.
Noise (spray washer and generator)	Moderate/low	Hearing protection within 25 ft when washer is operating unless equipment-specific sound level measurements indicate noise <85 dBA.	Daily site safety inspections.
Fire (isopropanol and gasoline)	Very low/low	Fuel and flammables stored in safety cans with flame arresters. Fire extinguisher rated ≥20B 25–75 ft from flammables storage. No ignition sources in fuel storage areas. Fuel storage areas (if any) marked with "No Smoking or Open Flame" signs. Bonding (metal to metal contact) during pouring. Gasoline powered equipment shut down during fueling.	Daily site safety inspections.
Exposure to chemicals (see **Table C-5**)	Very low/ low	Level D modified PPE, including nitrile or PVC gloves, disposable shoe covers for contact with potentially contaminated materials. Medical clearance for HAZWOPER work. Wash face and hands prior to taking anything by mouth.	Daily site safety inspections.
Exposure to radioactive materials (see **Table C-5**)	See above under Soil and Sediment Sampling (refer also to **Table C-5** and Section C.7).		
Temperature extremes	Low/low	Administrative controls. Shaded break area. Chilled drinks if temperature exceeds 70ºF. If impermeable clothing is worn, (1) a mandatory work/rest cycle will be announced and (2) workers will be notified to take unscheduled breaks if needed.	Temperature measurements at least twice per day and heart rate monitoring if personnel wear impermeable clothing.
Electrical shock	Low/high	GFCI for electrical hand tools.	Daily site safety inspections as appropriate.
Visual Surveying, Radiological Measurements, Geophysical Surveying, Civil Surveying, Other Non-Intrusive Tasks at Ground Level			
General safety hazards	Low/very low	Level D PPE. Buddy system. Site-specific training and HAZWOPER 40-hour training required.	Daily safety inspections.

Table C-4. Hazards Analysis
Jefferson Proving Ground, Indiana (Continued)

Safety and Health Hazards	Probability/Severity	Controls	Monitoring
Biological hazards (bees, ticks, Lyme disease, wasps, snakes)	Moderate/low	PPE (boots, work clothes). Insect repellant on boots and pants and elsewhere, as necessary. Pant legs tucked into boots or otherwise closed to minimize tick entry. Inspect for ticks during the day and at the end of each work day.	Visual survey.
Exposure to chemicals (see **Table C-5**)	Very low/very low	Level D PPE, including nitrile or PVC gloves for contact with potentially contaminated materials. Medical clearance for HAZWOPER work. Wash face and hands prior to taking anything by mouth.	Daily site safety inspections.
Exposure to radioactive materials (refer also to **Table C-5** and Section C.7)	Very low/very low	Level D PPE, including nitrile or PVC gloves. disposable shoe covers for contact with potentially contaminated material. Exclusion zone around contaminated areas. Medical clearance for HAZWOPER work. Minimize contact, remove PPE at step-off pad area, and frisk. See also Section C.7 on radiation protection.	Personnel and equipment surveyed out of exclusion zone. Work area dose rate monitoring and smearable contamination measurements.
Temperature extremes	Low/low	Administrative controls. Shaded break area. Chilled drinks if temperature exceeds 70ºF. If impermeable clothing is worn, (1) a mandatory work/rest cycle will be announced and (2) workers will be notified to take unscheduled breaks if needed.	Temperature measurements at least twice per day and heart rate monitoring if personnel wear impermeable clothing.

ALARA = as low as reasonably achievable
DAC = derived air concentration
dBA = decibels (audible)
ºF = degrees Fahrenheit
GFCI = ground fault circuit interrupter
HAZWOPER = hazardous waste operations and emergency response
lbs = pounds
LEL = lower explosive limit
MSDS = Material Safety Data Sheet
PID = photoionization detector
PPE = personal protective equipment
PVC = polyvinyl chloride
SSHP = Site Safety and Health Plan
SSHO = Site Safety and Health Officer

Table C-5. Potential Chemical Exposures
Jefferson Proving Ground, Indiana

Chemical	TLV, PEL, STEL, IDLH, or DAC[a]	Health Effects/ Potential Hazards[b]	Chemical and Physical Properties[b]	Exposure Route(s)[b]
Isopropyl alcohol (used for equipment decontamination)	TLV/TWA: 400 ppm STEL: 500 ppm	Irritation of eyes, skin, respiratory system; headache, drowsiness; flammable liquid	Colorless liquid; VP: 33 mm; IP: 10.10 eV; FP: 53°F	Inhalation, Ingestion
Liquinox (used for decontamination)	TLV/TWA: NA	May cause local irritation to mucous membranes	Aqueous liquid, odorless, nonflammable	Ingestion, Contact
Uranium 238	TLV: 0.2 mg/m^3; A1 DAC: 2E-11 µCi/ml	Cancer Kidney damage	Solid; VP: NA; FP: NA	Inhalation, Ingestion, Contact
Uranium 234	TLV: 0.2 mg/m^3; A1 DAC: 2E-11 µCi/ml	Cancer Kidney damage	Solid; VP: NA; FP: NA	Inhalation, Ingestion, Contact
Uranium 235	TLV: 0.2 mg/m^3; A1 DAC: 2E-11 µCi/ml	Cancer Kidney damage	Solid; VP: NA; FP: NA	Inhalation, Ingestion, Contact

[a] From 1999 Threshold Limit Values, NIOSH Pocket Guide to Chemical Hazards (NIOSH 2001), or 10 CFR 20.
[b] From NIOSH Pocket Guide to Chemical Hazards (NIOSH 2001).

A1 = confined human carcinogen
CFR = Code of Federal Regulations
DAC = derived air concentration
FP = flash point
IDLH = immediately dangerous to life or health
IP = ionization potential
µCi/ml = microcuries per milliliter
mg/m^3 = milligrams per square meters
NA = not available
NIOSH = National Institute of Occupational Safety and Health
PEL = permissible exposure limit
ppm = parts per million
STEL = Short-term exposure limit
TLV = threshold limit value
TWA = time-weighted average
VP = vapor pressure

C.2.3.1 General Information

The following UXO principles apply while onsite:

- The cardinal principle to be observed involving explosives, ammunition, severe fire hazards, and/or toxic materials is to limit the exposure of a minimum number of personnel, for the minimum amount of time, to a minimum amount of hazardous material consistent with a safe and efficient operation.
- The age or condition of ordnance does not decrease its effectiveness. Ordnance that has been exposed to the elements for extended periods becomes more sensitive to shock, movement, and friction due to the fact that the stabilizing agent in the explosives may be degraded.
- Consider ordnance that has been exposed to fire as extremely hazardous. Chemical and physical changes may have occurred to the contents, which render them more sensitive than they were in their original state.
- DO NOT be misled by markings on the ordnance stating "practice bomb," "dummy," or "inert." Even practice bombs contain explosive charges that are used to mark/spot the point of impact. The item(s) also could be mis-marked.
- DO NOT rely on color codes for positive identification of ordnance item(s) or their contents.
- Always assume that ordnance contains a live charge until it can be ascertained otherwise.

C.2.3.2 Onsite Instructions

The following instructions apply while onsite:

- If UXO is encountered during sampling, project personnel will immediately cease all activity.
- Personnel will proceed to a safe evacuation distance from the UXO.
- Notify the appropriate U.S. Army personnel of the location of the UXO.
- DO NOT touch or move any ordnance regardless of the markings or apparent condition.
- DO NOT visit an ordnance site if an electrical storm is occurring or approaching. If a storm approaches during a site visit, leave the site immediately and seek shelter.
- DO NOT use radios or cellular phones in the vicinity of suspect ordnance.
- DO NOT walk across an area where the ground cannot be seen. If dead vegetation or animals are observed, leave the area immediately because of potential contamination by chemical agents.
- DO NOT drive vehicles into a suspected UXO area; use clearly marked lanes.
- DO NOT carry matches, cigarettes, lighters, or other flame-producing devices onto an UXO site.

There is no evidence of the potential existence of chemical warfare materiel (CWM) or CWM byproducts on JPG. In the event suspect CWM is encountered, all work will cease immediately and project personnel will be evacuated along cleared paths upwind from the discovery. A team consisting of a minimum of two personnel will immediately secure the area to prevent unauthorized access. Reporting procedures will be in accordance with this SSHP.

C.3 STAFF ORGANIZATION AND RESPONSIBILITIES

Overall coordination and implementation of the environmental sampling described in this plan is the responsibility of the SAIC Project Manager. The roles and responsibilities of key personnel for the ERM program are listed in **Table C-6**.

Table C-6. Roles and Responsibilities for the ERM Program
Jefferson Proving Ground, Indiana

Role	Organization/ Person	Responsibility
Project Manager	SAIC Corinne Shia	Assures all sample/survey activities are performed in accordance with this plan and that all project quality, compliance, and health and safety requirements are followed.
Sample Manager	SAIC Michael Cox	Assures samples are handled in accordance with the project sampling and analysis guide and that all geographical information system (GIS) data are collected and analyzed in a defensible manner.
SAIC Field Manager	SAIC Michael Cox	Enforces compliance with the project SSHP; coordinates onsite operations, including subcontractor activities; ensures that subcontractors follow the requirements of this SSHP; coordinates and controls any emergency response actions; ensures that at least two persons currently certified in first aid/CPR are onsite during site operations; performs (or ensures) a daily safety inspection and documents the inspection on the daily safety inspection form attached; and maintains current copies of the project SSHP and the SAIC EC&HS Manual onsite.
Site Safety and Health Officer	SAIC Mark Pederson	Has primary responsibility for the following: conducts and documents daily safety inspections; completes the health and safety debrief in EC&HS Procedure 20; stops work or upgrades protective measures (including protective clothing) if uncontrolled health and safety hazards are encountered; conducts a site-specific pre-entry health and safety briefing covering potential chemical and physical hazards, safe work practices, and emergency procedures; maintains documentation of MSDSs for applicable materials used at the site; provides training for site workers and visitors; maintains environmental and personal exposure monitoring results; completes notification of accidents/incidents; conducts medical surveillance; confirms that all onsite personnel have received the training listed in Section C.4 of this SSHP; ensures that all monitoring equipment is operating according to the manufacturer's specifications and performs field checks of instrument calibration; updates the project SSHP (field changes) to ensure that it adequately identifies all tasks and significant hazards at the site and notifies project personnel and the SAIC Field Manager of changes; investigates accidents and near accidents and reports (in concert with Field Manager); conducts daily "tailgate" safety briefings; and controls visitor access to the exclusion zone.
SAIC Site Radiation Safety Officer	SAIC Mark Pederson	Conducts site training and audits as needed; assesses radiological exposure measurements; and ensures compliance with EM-385-1-1 (USACE 1996), EM-385-1-80 (USACE 1997), and other Federal and State regulations through guidance in SAIC EEMG Health Physics procedures and program oversight.
UXO Safety Officer	SAIC Michael Cox	Implements the UXO safety plan developed for these ERM program activities in consultation with the JPG Site Manager.
Site Manager	U.S. Army Ken Knouf	Provides oversight, direction, and coordination for activities within the installation boundaries.

CPR = cardiopulmonary resuscitation
EC&HS = Environmental Compliance and Health and Safety
EEMG = Engineering and Environmental Management Group
ERM = environmental radiation monitoring
GIS = geographical information system
RSO = Radiation Safety Officer
SAIC = Science Applications International Corporation
SSHP = Site Safety and Health Plan
USACE = U.S. Army Corps of Engineers
UXO = unexploded ordnance

C.4 TRAINING

Personnel who participate in field activities associated with this project are subject to the training requirements presented in **Table C-7**. Field activities include all the tasks specified in **Section C.2** of this plan as well as any other unspecified tasks that take place. Examples of other tasks include conveying sampling equipment to field crews, observing field crews, and transporting samples within the confines of the site. Activities such as driving or walking on paved roads that are not within potentially contaminated areas, paperwork or meetings inside routinely occupied (safe) buildings, and paperwork and similar activities inside office trailers are not field activities and are not subject to these training requirements. Casual visitors, such as package deliverers, who access only the office or staging areas are not subject to these training requirements.

Table C-7. Training Requirements
Jefferson Proving Ground, Indiana

Training	Worker	Supervisor	Site Visitor
Hazardous Waste Safety (40-hour, 3-day OJT)	U	U	U
Hazardous Waste Safety Annual Refresher (8-hour)	U	U	U
Hazardous Waste Safety Supervisors Training (8-hour)	X	U	X
General Hazard Communication Training (contained in 40-hour and 8-hour courses)	U	U	U
Hearing Conservation Training (for workers in hearing conservation program; contained in 40-hour and 8-hour courses)	U	U	U
Radiation Worker Training	U	U	X
Site Worker Training	U	U	X
Site Specific Hazard Communication (contained in pre-entry briefing)	U	U	X
Safety Briefing (daily and whenever conditions or tasks change)	U	U	X
Site Visitor Training	X	X	U
First Aid/CPR (standard Red Cross or equivalent)	≥2 workers	X	X

U = Required
CPR = cardiopulmonary resuscitation
X = not required
OJT = on-the-job training

Prior to conducting work onsite, members of the team will be required to attend the JPG safety briefing conducted by the JPG Site Manager. At a minimum, this training will cover site access requirements, installation rules and regulations, and emergency response procedures for onsite personnel. All survey team personnel will follow the emergency response procedures in effect for JPG.

The SSHO will verify completion of all training requirements, and proof of required training will be maintained onsite.

C.4.1 Offsite Training

The 40-hour Hazardous Waste Site Worker course is required for field sampling activities or for any activity that poses the potential to encounter hazards associated with hazardous waste. Three days of relevant field experience are required in conjunction with this training.

The 8-hour Hazardous Waste Safety Refresher course is required annually to maintain currency in the 40-hour course.

The Hazardous Waste Safety Supervisors Training is required for personnel who directly supervise hazardous waste site workers. This is an 8-hour course that must be taken once. Note that the 40-hour course is a prerequisite.

General Hazard Communication Training is required for all site workers. This training must communicate the risks and protective measures for chemicals and radionuclides that employees may encounter. This requirement is met by taking the 40-hour Hazardous Waste Site Worker course, annual refreshers, and site-specific training.

Hearing Conservation Training is required on an annual basis by Title 29, Code of Federal Regulations, Part 1910.95 (29 CFR 1910.95) for all employees enrolled in a hearing conservation program. This category will include all employees exposed to occupational noise in excess of 85 decibels (audible) (dBA) on a time-weighted average. This refresher training is provided as part of the Hazardous Waste Safety Refresher course.

C.4.2 Site Worker Training

Personnel onsite must have received the site-specific safety training. Two versions of this training will be used. The site worker version will contain full information on site hazards, hazard controls, and emergency procedures. A shortened version will be used for visitors who will be onsite for short times and who will not do hands-on work. This shortened version will contain the hazard information that is directly relevant to the purpose of the visit. Signatures of those attending and the type of briefing must be entered in project documentation before site access will be granted. The site-specific training will include the following site-specific information, as appropriate:

- JPG site-specific training
- Overview of site hazards and conditions
- Names of site health and safety personnel and alternates
- Contents of the project SSHP
- Hazards and symptoms of contaminant exposure (chemical and radiological)
- Hazards and symptoms of chemicals used onsite
- Physical hazards in the workplace
- Location and availability of the written hazard communication program
- Site and task PPE (including purpose, donning, doffing, proper use)
- Safe work practices to minimize risks
- Safe use of engineering controls and equipment
- Medical surveillance requirements

- Site control measures
- Reporting requirements for spills and emergencies
- Decontamination procedures for cleanup of chemical and radiological contamination
- Contingency plans (communications, phone numbers, emergency exits, assembly point, etc.)
- Hearing conservation (for noisy work if worker does not have documented hearing conservation training)
- Spill containment procedures (reporting, cleanup methods, etc.)
- Emergency equipment locations and use (fire extinguishers, spill kits, etc.).

Safety briefings will be held daily and when conditions or tasks change. These briefings will be conducted by the SSHO and/or Field Manager and will be attended by all site workers and supervisors. These briefings will address site-specific safety issues and will be used as an opportunity to refresh workers on specific procedures and to address new hazards and controls.

Site workers scheduled to perform field activities as defined in Section C.4. will undergo Radiation Worker Training. Successful completion of the Radiation Worker Training provides the necessary knowledge to work safely in all areas where field activities will be performed and the qualifications needed to become a Radiation Worker. Radiation Worker Training will be conducted by the SSHO.

C.4.3 Site Visitor Training

Site visitors will receive a briefing specific to hazards and controls associated with their intended site duties from the SSHO and/or Field Manager. A site visitor will be escorted by qualified personnel when in a controlled area to ensure that the individual will not be exposed to hazards for which he/she has not received training.

C.4.4 Documentation

Documentation of the required training will be maintained in the onsite project files. This documentation will include copies of 40-hour, 8-hour refresher, and supervisor training certificates; copies of first aid/cardiopulmonary resuscitation (CPR) certificates; and records showing the topics covered, trainer, and signatures of those attending onsite training.

C.5 PERSONAL PROTECTIVE EQUIPMENT

The minimum level of protection that will be used for non-intrusive survey activities at this site is Level D Protective Equipment (safety boots, hard hat, safety glasses). For intrusive activities such as soil sampling and for activities that involve handling DU fragments, the minimum level of protection will be Modified Level D Protective Equipment. Modified Level D Protective Equipment is defined as:

- Impermeable disposable inner gloves (i.e., nitrile, polyvinyl chloride [PVC], or equivalent)
- Safety boots (ANSI Z41)
- Hard hat (ANSI Z89.1)
- Safety glasses with side shields (ANSI Z87.1).

Additional PPE, such as Tyvek® coveralls, boot covers, or cotton/leather gloves, may be required based on conditions encountered during the survey or new information on site contaminants not yet presented. The designated onsite SSHO or Radiation Safety Officer has the responsibility for determining if an upgrade in PPE requirements is required after the survey team has mobilized to the site.

PPE for site tasks is based on potential site-specific physical, radiological, and chemical hazards. In cases where multiple hazards are present, a combination of protective equipment will be selected so that adequate protection is provided for each hazard. This section emphasizes the programmatic requirements for PPE. For task-specific PPE requirements, see Section C.2, the Hazard/Risk Analysis section of this SSHP. In accordance with USACE requirements, two complete sets of PPE will be maintained by SAIC onsite for use by Government personnel during site visits.

The SSHO may raise or lower the level of PPE worn by the teams, depending upon the site-specific hazards encountered in the field. Prior to lowering the level of PPE, the Project Manager, Field Manager, and Health and Safety Manager will be contacted/consulted and the results documented. If site conditions are such that the level of PPE is insufficient or work must be stopped, the SSHO will take appropriate action immediately and the appropriate personnel (Project Manager, Field Manager, and Health and EEMG Safety Manager) will be contacted afterward. Criteria indicating a possible need for reassessment of the PPE selection include any of the following:

- Commencing of an unplanned work phase (hazard not previously assessed)
- Working in unplanned temperature extremes
- Finding evidence of contamination, such as discolored soil or elevated instrument readings near the soil
- Exceeding the action limits of chemical or radiological hazards
- Changing the work scope so that the degree of contact with contaminants changes.

C.5.1 Types of Protective Equipment

This section identifies the types of protective clothing that may be used for the ERM program. Requirements for task-specific levels of protective clothing are presented in the Hazards Analysis table (**Table C-4)** of this SSHP. Levels of protection that will be used to protect against chemical, radiological, and physical hazards at this site include the following:

- Modified Level D Protective Equipment
  - Tyvek® or equivalent coveralls, pants taped closed over boots
  - Latex, nitrile, or PVC gloves, taped closed over coverall sleeves
  - Disposable boot covers, if required
  - Safety boots
  - Hearing protection (if necessary)
  - Hard hat (if overhead hazards are present)
  - Safety glasses with side shields
  - Splash goggles or face shield (if splash hazard for eye or face/skin is present)

- Level D Protective Equipment
  - Coveralls/field clothes
  - Safety boots
  - Safety glasses with side shields
  - Hearing protection (if necessary)
  - Hard hat (if overhead hazards are present)
  - Leather or similar work gloves if sharp or abrasive materials are handled.

C.5.2 Cleaning, Storage, and Program Verification

If site tasks require the use of protective clothing, disposable clothing will be used. Used disposable PPE will be damaged, precluding any reuse. Unused protective clothing will be stored in clean staging areas until needed. The SSHO will verify that the PPE in use is appropriate and is being used properly.

C.6 MEDICAL SURVEILLANCE

All employees performing onsite work will be enrolled in a medical surveillance program to meet the requirements of 29 CFR 1910.120(f), 1910.134, 1910.20 and SAIC EC&HS Procedures 12 (Medical Surveillance) and 20 (Hazardous Waste) (SAIC 2003) to assess and monitor workers' health and fitness for employment in the field. Documentation of medical clearances will be maintained onsite during the project.

C.7 RADIOLOGICAL PROTECTION

Based on the site history, nature and extent of radiological contamination, and results of the ongoing ERM program, radiological hazards to workers from ingestion, inhalation, and direct exposure to DU are expected to be low. Radiological hazards and controls are identified in **Table C-4**. Additional measures to ensure worker safety follow.

C.7.1 Training

As required by Section 06.E.03 and 10 CFR 19 of EM 385-1-1 (USACE 1996), personnel who have the potential to receive 100 millirem (mrem) total effective dose limit in a year must be radworker trained. Although onsite workers involved in sampling activities at JPG are not expected to receive a dose of 100 mrem/yr, each person will receive radworker training so that doses might be kept as low as reasonably achievable.

Radworker training will include, at a minimum, 4 hours of instruction in the following aspects of radiological safety: health effects of ionizing radiation, exposure limits (including those for pregnant workers), use of dosimetry and instruments, effects of radiation on the embryo/fetus, employee rights and responsibilities, site contaminants and probability of exposure, required monitoring, and exposure control methods (see Section C.4).

C.7.2 Radiological Exposure Monitoring

Past environmental sampling has indicated that uranium concentrations in the water, sediment, and soil are not sufficient to require radiological monitoring. If changing conditions warrant, monitoring for external exposure and breathing zone air sampling will be conducted.

C.8 STANDARD OPERATING SAFETY PROCEDURES

Site safety and health requirements for site tasks are based on potential physical, radiological, and chemical hazards. The sampling team will follow the general site safety and health requirements documented in this plan. These documents and procedures comply with the NRC, OSHA, and USACE regulations. The requirements for UXO safety are in accordance with the UXO procedures defined in Section C.2.

This section presents those general safety rules that apply to all operations performed by SAIC and its subcontractors. These requirements are generic in the sense that they apply to all projects. Therefore, there may be portions of this section that do not apply to this specific program. The provisions of the plan are mandatory for all onsite employees, subcontractors, and visitors.

C.8.1 Site Rules

The following rules apply to all site activities:

- Daily safety briefings ("tailgates") will be conducted by the Field Manager and/or SSHO to inform personnel of new hazards or procedures.
- The SSHO, project personnel, and management personnel are responsible for suspending or stopping work and requiring all personnel to evacuate the affected area if any of the following situations occur:
  - Inadequate health and safety precautions on the part of any onsite personnel
  - Potential significant environmental insult as a result of planned activities.
- Personnel will perform only those tasks that they believe they can do safely.
- Personnel will notify the SSHO of any medical conditions (e.g., allergy to bee stings, diabetes, pregnancy) that require special consideration.
- Personnel will maintain proper workplace housekeeping to minimize the potential for tripping and other accidents.
- Contact with potentially contaminated substances will be avoided.
- Spills will be prevented to the greatest extent possible. In the event that a spill occurs, the material will be contained, cleaned up, and reported as necessary.
- Eating, drinking, smoking, chewing gum or tobacco, and other practices that increase the probability of hand-to-mouth transfer are prohibited in contaminated and potentially contaminated areas.
- Workers will wash their hands and faces upon leaving the work area and prior to eating or drinking.
- All injuries and accidents requiring more than first aid will be reported to the SSHO, Project Manager, EEMG Health and Safety Manager, and the U.S. Department of Army.

- All onsite workers will abide by a buddy system. Members of a buddy team will maintain verbal or visual contact.

C.8.2 Sources of Ignition and Fire Protection

This work will be performed in conformance with EM-385-1-1, Section 9 (USACE 1996). The following procedures will be implemented:

- Sources of ignition will be kept at least 15 m from flammables storage areas.
- Flammables storage areas will be posted with signs indicating, "No smoking or open flame."
- At least one fire extinguisher with a rating of not less than 20-B will be kept 8–23 m from all flammables storage areas.
- An approved flammables cabinet (if necessary) will be used to store 25 or more gallons of flammable liquid.
- Flammable liquids (other than decontamination solvents) will be kept in safety containers with flame arresters.

C.8.3 Electrical Safety

This work will be conducted in conformance with 29 CFR 1910, Subpart S, and EM-385-1-1, Section 11 (USACE 1996). All portable electrical equipment will be double insulated or grounded and connected through a ground fault circuit interrupter.

C.8.4 Hazard Communication

Hazard communication will be governed by SAIC EC&HS Procedure 8, Hazard Communication (SAIC 2003), 29 CFR 1910.1200, and EM-385-1-1 Section 8 (USACE 1996). At a minimum, the following steps will be taken:

- All hazardous materials used as part of this effort onsite will be labeled to comply with the hazard communication standard as follows:
  - Clear labeling as to the contents
  - The appropriate hazard warning
  - The name and address of the manufacturer.
- Material Safety Data Sheets (MSDSs) will be available onsite for all hazardous materials used as part of this effort.
- Site-specific training will include the hazards posed by site chemicals, protective measures, and emergency procedures, including reporting requirements in the event of releases or spills.

- Copies of MSDSs for all hazardous chemicals (chemicals brought onsite) will be maintained in the work area. MSDSs will be available to all employees for review during each work shift.

C.8.5 Sanitation

Means for washing hands and faces prior to eating will be provided at the work site. Potable drinking water will be provided in labeled, sanitary dispensers.

C.8.6 Heat/Cold Stress

Important factors in preventing heat stress-induced illnesses are acclimatization, consumption of copious quantities of fluids, and appropriate work and rest cycles. General controls will consist of making fluids readily available, using the buddy system, and taking scheduled and unscheduled breaks in temperature-controlled areas as necessary. The specific steps identified below will be followed to reduce the potential for heat stress-induced illness:

- If ambient temperatures exceed 70 degrees Fahrenheit (°F), site training will include heat stress control, recognition of heat stress-induced illness, and first aid for heat stress.

- If ambient temperatures exceed 70°F, workers will be instructed to monitor their own and their buddy's condition relative to heat stress.

- Workers will be allowed to take unscheduled breaks if needed.

- Workers wearing Tyvek® or other impermeable clothing when ambient temperatures exceed 70°F will be monitored for heat stress by taking their pulses at the beginning of each rest period. If any worker's heart rate exceeds 110 beats per minute, the next work period will be shortened by one third (National Institute for Occupational Safety and Health, Occupational Safety and Health Administration, U.S. Coast Guard, and U.S. Environmental Protection Agency [NIOSH/OSHA/USCG/EPA] 1985).

- An initial work and rest cycle will be established for employees wearing impermeable clothing based on the air temperature. The length of each work period will be as follows (NIOSH/OSHA/USCG/EPA 1985):

°Farenheit	**Work Period**
72.5–77.5°F	120 minutes
77.5–82.5°F	90 minutes
82.5–87.5°F	60 minutes
87.5–90°F	30 minutes
≥90°F	15 minutes

C.8.7 Site Communication

The field crew will be equipped with a cellular phone. Section C.10 identifies communication requirements during emergencies.

C.9 PERSONAL HYGIENE AND DECONTAMINATION

A system of procedures will be used to control the spread of contamination from the exclusion zone (Restricted Area) and to ensure that workers are sufficiently free of contamination to preclude adverse health effects. PPE doffing, radiological contamination scan(frisk), and personnel decontamination are part of this system. This section presents basic requirements for personnel decontamination keyed to the level of protection. These requirements may be modified by the SSHO if improvements are needed. The Hazards Analysis section (Section C.2) describes task-specific PPE.

C.9.1 Level D Protection Doffing Sequence

- **Step 1:** Equipment drop

  Place potentially contaminated equipment in a designated area.

- **Step 2:** Removal of disposable gloves and boot covers (if worn)

  Deposit disposable gloves and boot covers in a designated container. Note that this step is necessary only if gloves and boot covers are in use.

- **Step 3:** Frisk

  Examine hands, shoes, and any other areas that may have become contaminated. Because of the unlikelihood of contamination, the individual may perform the frisk. Any personal contamination will be removed with tape, moistened towel, or soap and water.

C.9.2 Equipment Decontamination

Sampling and related equipment will be decontaminated to a level sufficient to prevent cross-contamination of subsequent samples. This stringent requirement ensures that decontaminated sampling equipment is sufficiently clean from a personnel contact perspective. Decontamination of sampling equipment will be performed in accordance with Field Technical Procedure (FTP)-400 (SAIC 2003).

C.10 EMERGENCY PROCEDURES AND COMMUNICATION

In the event of an accident or incident, the SAIC Field Manager will notify the U.S. Army Radiation Protection Officer (RPO) immediately according to the requirements of EM-385-1-1 (USACE 1996). Additional reporting requirements and associated procedures are documented in this section.

C.10.1 Emergency Procedures

All accidents will be investigated and reported within 24 hours as specified in EM-385-1-1 (USACE 1996). The Accident Report (ENG Form 3394) will be completed and submitted to the U.S. Army at this address:

Joyce Kuykendall, RPO
U.S. Department of Army
SBCCOM
ATTN: AMSSB-RCB-RS
E5183 Blackhawk Road

APG, MD 21010-5424

All personnel working onsite will be trained in the requirements of this section. This training will include recognizing emergencies, reporting emergencies to the Field Manager or SSHO, and responding to emergencies. Employees also will be informed of any changes in potential emergency or response plans.

Field crews will use a variety of equipment that could cause injuries. In support of emergency operations, the SSHO or Field Manager will designate the assembly area and evacuation routes. In the event of a medical emergency, the Field Manager will notify the local emergency medical service immediately. Personnel with serious injuries will be stabilized onsite pending arrival of emergency medical service personnel. At least one first aid or CPR-trained individual will be onsite at all times, and this person will provide first aid pending release of the injured person to emergency medical staff. Contaminated injured personnel will be decontaminated to the extent feasible. Personnel with minor injuries will follow normal decontamination procedures. Personnel with serious injuries will be decontaminated, if necessary, by disrobing and wrapping in a blanket. Decontamination may be bypassed in the event of life-threatening injuries or illnesses.

The emergency groups and their telephone numbers listed in **Table C-8** will be posted onsite. A cellular phone will be present in the field and available for use.

Table C-8. Emergency Points of Contact
Jefferson Proving Ground, Indiana

Organization	Phone
Ambulance	911
Fire Department	911
King's Daughters' Hospital	911 or (812) 265-5211
JPG Site Manager (Ken Knouf)	(812) 273-2551
SAIC SSHO (Mark Pederson)	(314) 770-3053
SAIC Project Manager (Corinne Shia)	(703) 318-6993
U.S. Army SBCCOM (Joyce Kuykendall)	(410) 436-7118
SAIC EEMG Health and Safety Manager (Steve Davis)	(865) 481-4755

EEMG = Engineering and Environmental Management Group
JPG = Jefferson Proving Ground
SAIC = Science Applications International Corporation
SBCCOM = Soldier and Biological Chemical Command
SSHO = Site Safety and Health Officer

King's Daughters' Hospital, located in Madison, will be used for any required medical services. Medical emergencies will be handled by dialing 911 for medical assistance and contacting the JPG Site Manager to serve as an escort to the sampling location.

Directions to King's Daughters' Hospital are as follows: exit the Main Gate, drive south on Highway 421, and turn right on 4th Street to the emergency entrance (**Figure C-1**).

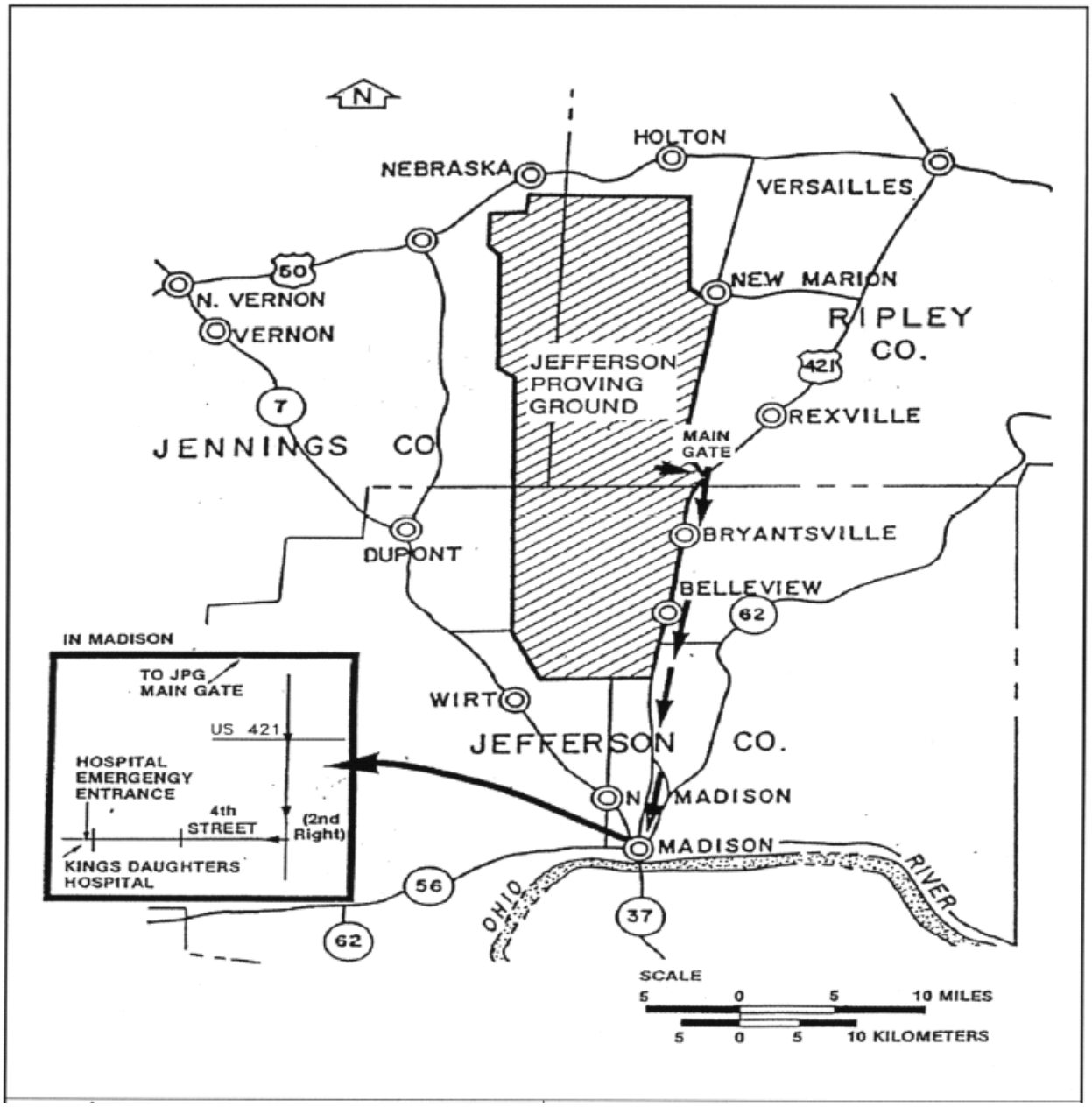

Figure C-1. Directions from Jefferson Proving Ground to King's Daughters' Hospital

C.10.2 Emergency Equipment

Several items of emergency equipment will be maintained at the work site. Any incident that clearly is not controllable by personnel wearing standard site clothing plus protective gloves and using the listed equipment will require reevaluation by the SSHO. If the SSHO does not feel that onsite personnel can safely control the emergency with the available equipment, the crew will use alternate approaches, such as allowing a small fire to burn out or evacuating the site. The required emergency equipment includes the following:

- A 16-unit first aid kit indoors or in weatherproof container, inspected weekly

- One 5-pound ABC fire extinguisher in each work vehicle
- Basic spill kit suitable to handle small spills of decontamination fluids, hydraulic fluid, or fuels and containing sorbent pads, tubes, and nitrile or similar gloves
- Telephone and/or portable radios.

C.11 LOGS, REPORTS, AND RECORDKEEPING

A system of reports and logs will be used to document activities related to site health and safety. These reports will include injuries, accidents, and near accidents; interpretations of the SSHP or regulations; interactions with auditors, regulators, and U.S. Army personnel; and any off-normal events:

- Accident and injury reports for all accidents other than first aid cases
- Training certificates
- Medical clearance forms
- Related procedures, such as for equipment and personal decontamination
- The health and safety debrief form contained in EC&HS Procedure 20 (SAIC 2003), which should be completed by the SSHO at the end of the project and submitted to the SAIC EEMG Health and Safety Manager.

C.12 REFERENCES

29 CFR 1910 and 1926 (Title 29, Code of Federal Regulations, Parts 1910 and 1926). OSHA Standards (Part 1910) and Safety and Health Regulations for Construction (Part 1926). Occupational Safety and Health Administration.

10 CFR 20. Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings. Nuclear Regulatory Commission.

National Institute for Occupational Safety and Health 2001. Pocket Guide to Chemical Hazards. November.

NIOSH/OSHA/USCG/EPA (National Institute for Occupational Safety and Health, Occupational Safety and Health Administration, U.S. Coast Guard, and U.S. Environmental Protection Agency). 1985. Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities. October 1985.

National Institute for Occupational Safety and Health 1997. Pocket Guide to Chemical Hazards.

USACE (U.S. Army Corps of Engineers) 1994. Safety and Occupational Health Document Requirements for Hazardous, Toxic, and Radioactive Waste and Ordnance and Explosive Waste Activities, Attachment 2, ER 385-1-92, U.S. Army Corps of Engineers. March 1994

USACE 1996. Safety and Health Requirements Manual, EM-385-1-1, U.S. Army Corps of Engineers. September.

USACE 1997. Radiation Protection Manual, EM-385-1-80, U.S. Army Corps of Engineers. May.

SAIC (Science Applications International Corporation) 2003. Environmental Safety and Health (ES&H) Manual. Key procedures applicable to this HSSP include: EC&HS Procedure 4, Accident Reporting; EC&HS Procedure 6, OSHA Recordkeeping and Reporting; EC&HS Procedure 7, Hazardous Waste Disposal; EC&HS Procedure 8, Hazard Communication and Hazardous Chemical Control; EC&HS Procedure 9, Respiratory Protection Program; EC&HS Procedure 10, Confined Space Entry; EC&HS Procedure 11, Lock Out/Tag Out; EC&HS Procedure 12, Medical Surveillance; EC&HS Procedure 13, Personal Protective Equipment; EC&HS Procedure 15, Hearing Conservation and Noise Control; EC&HS Procedure 19, Radiation Protection; EC&HS Procedure 20, Hazardous Waste Operations; EC&HS Procedure 25, Management of Investigation Derived Waste; EEMG HP-107, Control of Airborne Radiation Exposure.

This page intentionally left blank.